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NATURAL ICING RE-EVALUATION OF THE EH-60A QUICK FIX HELICOPTER

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AVIATION ENGINEERING FLIGHT ACTIVITY
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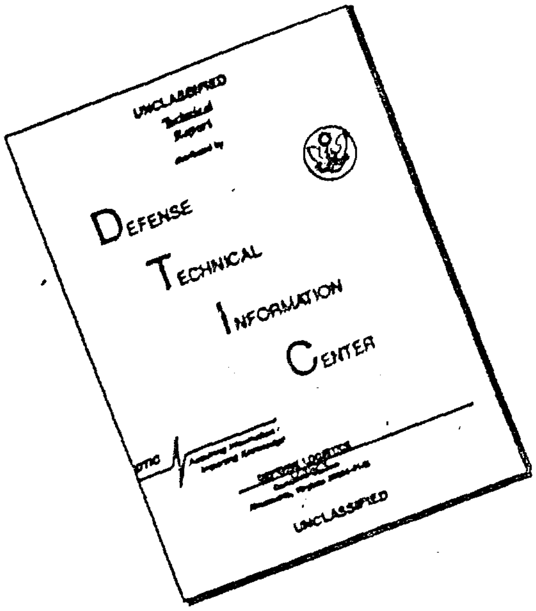

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Natural icing flight tests were conducted on the EH-60A helicopter (USA S/N 86-24569) Quick Fix system to establish an icing flight envelope with the AN/ALQ-151(V)2 countermeasures system installed. Eight flights with a total of 11.1 productive test hours were flown in a natural icing environment at Duluth, MN between 25 February and 13 March 1989. Two deficiencies were noted: the design of the electronic countermeasures (ECM) antenna assembly and mount which caused excessive ice-induced oscillations and subsequent component failure and the poor reliability of the integrated inertial navigation system (IINS). Two icing-related shortcomings were noted: the loosening of the direction finding (DF) dipole antennas during flight in icing conditions and the inaccuracy of the liquid water content (LWC) readings of the Rosemount icing rate meter. The poor integration of the IINS and flight instruments which prevented the direct display of TACAN information was also a shortcoming. One previously identified icing-related deficiency and seven previously identified icing-related shortcomings of the UH-60A/EH-60A helicopter were re-evaluated and remain uncorrected. The EH-60A Quick Fix helicopter, with modified DF antenna insulator housings (part no. 1951-1-4116-4), should be released for flight in moderate icing conditions with the ECM antenna retracted only. The design of the DF antenna insulator housings should be improved to eliminate the requirement for maintenance after each icing flight.

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INTRODUCTION

BACKGROUND

1. The UH-60A, with production deicing kit, has been cleared for flight into moderate icing conditions. The EH-60A helicopter Quick Fix system comprises a UH-60A modified to accept an AN/ALQ-151(V)2 countermeasures system and other mission equipment. The associated antennas of the EH-60A alter the overall ice accretion characteristics. The YEH-60A and the EH-60A have undergone natural and artificial icing airworthiness tests (refs 1 and 2, app A) and have been determined to be unsuitable for flight into icing environments. The U.S. Army Aviation Systems Command (AVSCOM) directed the U.S. Army Aviation Engineering Flight Activity (AEFA) to conduct further natural icing tests of the EH-60A helicopter (ref 3) with revised antenna configuration in accordance with the approved test plan (ref 4). Specific differences between the test aircraft and previously tested configurations were upgraded direction finding (DF) antenna insulator housings; an improved electronic countermeasures (ECM) antenna actuator assembly; the installation of dummy active DF antennas; and extended landing gear sponsons.

TEST OBJECTIVE

2. The objective of this test was to obtain limited natural icing flight test data to provide AVSCOM with the basis for establishing an envelope for flight into moderate icing conditions for the EH-60A helicopter Quick Fix system.

DESCRIPTION

3. The EH-60A helicopter Quick Fix system is a twin turbine, single main rotor helicopter designed to have an all-weather, day and night capability to identify, locate and jam ground based communications transmissions. The airframe is a UH-60A helicopter modified to accommodate special electronic mission equipment and aircraft survivability equipment. The UH-60A de/anti-icing equipment comprises main and tail rotor blade electrical deicing; a Rosemount ice detector/icing rate meter; electrical pitot tube, droop stop and windshield anti-icing heaters; and engine intake anti-ice protection by bleed air. External changes to the UH-60A as a result of the installation of the Quick Fix system include a single retractable ECM whip antenna underneath the rear fuselage, two DF dipole antennas on each side of the tail boom, one AN/ALQ-162 radar countermeasures antenna on the nose and another on the tail, four AN/ALQ-156 countermeasures antennas on the main fuselage and an additional M-130 chaff dispenser on the left side of the tailboom. The test aircraft was equipped with a hover infrared suppressor subsystem, an AN/ASN-132 integrated inertial navigation system, extended main landing gear sponsons (housing four/rev vibration absorbers) and four dummy active direction finding antennas mounted on the bottom of the fuselage. A description of the EH-60A is contained in the UH-60A Operator's Manual (ref 5) and additional details of the test aircraft, S/N 86-24569, are in appendix B.

4. A JU-21A configured with cloud calibration equipment was used to document icing cloud liquid water content (LWC), particle size, outside air temperature and relative humidity and is described in appendix C.

TEST SCOPE

5. Eight natural icing flight tests were conducted in the vicinity of Duluth, MN from 25 February to 13 March 1989. A total of 14.4 hours were flown of which 11.1 were productive in a natural icing environment. Specific test conditions are presented in table 1. Flight limitations contained in the operator's manual (ref 5) and the airworthiness release (ref 6) were observed during all flights. A crash rescue UH-1H was supplied by the U.S. Army Reserve from St. Paul, MN.

TEST METHODOLOGY

6. Natural icing tests were conducted by flying the aircraft under instrument flight rules in appropriate instrument meteorological conditions which had usually been located and documented in advance by the JU-21A chase aircraft. Following the icing encounter, the test aircraft exited the cloud and was immediately photographed in flight from the JU-21A. A landing was then accomplished as soon as possible to permit further photography. Ice shedding characteristics were qualitatively assessed by the test aircraft crew.

7. Aircraft Rosemount LWC readings were correlated with the rate of ice accretion on a visual ice accretion probe and with data obtained from the cloud calibration equipment on board the JU-21A. Video cameras were used to observe the behavior of the ECM antenna and to record DF dipole antenna motion and ice accretion. A detailed description of special equipment and instrumentation is presented in appendix C.

8. Data analysis methods and definitions of icing severities, shortcomings and deficiencies are presented in appendix D.

Table 1. Specific Test Conditions

Flt No.	Average Gross Weight (lb)	Average Longitudinal Center of Gravity (FS)	Average Density Altitude (ft)	Average Outside Air Temperature (°C)	Average Liquid Water Content[1] (gm/m^3)	Median Volumetric Diameter (μm)	Average True Airspeed (kts)	Total Time in Cloud (min)
1	15,910	359.5	4560	−14.5	.40	13–20	107	90
2	16,210	360.7	2930	-13.5	.25	13	103	60
3	16,200	360.7	10,700	-14.0	.27	20	107	80
4	16,330	361.0	4910	-6.5	.20	N/A	107	60
5	15,890	359.2	5620	-5.0	.23	N/A	105	95
6	16,020	359.9	3980	-12.0	.32	13	122	90
7	16,000	359.9	2230	-9.0	.44	14	123	96
8	15,980	359.8	2030	-10.0	.33	N/A	122	96

NOTE:

[1]See appendix D for method of calculation of average liquid water content.

RESULTS AND DISCUSSION

GENERAL

9. Natural icing tests were conducted to provide data for the establishment of a moderate icing flight envelope for the EH-60A helicopter Quick Fix system. Two deficiencies were noted: the design of the electronic countermeasures (ECM) antenna assembly and mount which caused excessive ice-induced oscillations and subsequent damage to both the ECM actuator and its mounting structure; and the poor reliability of the integrated inertial navigation system (IINS) navigational processing unit (NPU). The following shortcomings were identified: the loosening of the direction finding (DF) antennas after icing flights, the inaccuracy of the Rosemount icing rate meter and poor IINS/flight instrument integration. The deficient design of the ECM antenna assembly should be rectified before the EH-60A is permitted to operate in icing conditions with the ECM antenna extended. Regular post-icing flight maintenance of the DF antennas should be carried out until the design and assembly of the DF antenna insulator housings is improved.

ELECTRONIC COUNTERMEASURES ANTENNA

10. The ice accretion, ice shedding and oscillation characteristics of the extended ECM antenna were evaluated over a total of 3.1 hours during flights one through three. The effect of ECM antenna ice accretion on the operation of the ECM system was not assessed. The behavior of the ECM antenna was not observed during flights one and two since the forward camera was unserviceable. A 2 in. thick ice accretion along the lower 8 ft of the antenna was observed by the chase aircraft after exiting the icing conditions on flight one; no excessive oscillations were noted, retraction was normal and the ice shed after landing (fig. F-1, app F). After exiting the icing conditions on flight two, a uniform ice accretion of about 1 in. was observed; there were no excessive antenna oscillations and the ice shed after landing. During the initial part of flight three the ECM antenna oscillated laterally at approximately 4 Hz with a tip amplitude of about ±6 in. After 20 minutes of icing the oscillation rapidly increased to a tip amplitude of ±2 ft with visible movement of the actuator assembly and its mounting structure. After a further 13 minutes the oscillations suddenly stopped and the antenna hung slightly off-center, with only small oscillations, until retraction (fig. F-2). After exiting the icing conditions the chase aircraft observed a uniform 1 1/2 - 2 in. ice accretion along the lower 8 ft of the antenna with 1/2 in. of ice on the upper 1 ft. During retraction the antenna hesitated at 30 degrees extension before stopping at 5 degrees extension with the tip displaced 6 in. laterally from the cradle (fig. F-3). The ANTENNA RETRACTED advisory light remained out and the ANTENNA EXTENDED warning illuminated during approach and landing.

11. Post-flight airframe inspection revealed the following damage: a fatigue fracture of the left pivot pin which allowed the antenna to move laterally and bend the right pivot pin (fig. F-4); cracks in both the composite actuator mounting structure and the metal ground plane (figs. F-5 and F-6); and debonding and loss of material at the joint between the base of the antenna and the insulation collar (fig. F-7). After a review of the in-flight video recordings, the foregoing damage was attributed to the lateral oscillations of the ECM antenna. During antenna retraction the misalignment caused by the pivot pin

failure had allowed the antenna base to contact the actuator mechanism causing damage to several components (figs. F-8 and F-9). The damaged ECM antenna assembly and mount were replaced by a blanking plate during subsequent flights. The design of the antenna assembly and mount is deficient because it allows excessive ice-induced oscillations, resulting in structural damage and component failure. The design of the ECM antenna/mount assembly should be improved to either prevent ice accretion or render the ice-induced oscillations benign. Further testing should be conducted before the EH-60A is released for flight in icing conditions with the ECM antenna extended. Testing should be accomplished to determine the effect of ECM antenna ice accumulation on the operation of the AN/ALQ-151(V)2 countermeasures system.

DIRECTION FINDING DIPOLE ANTENNAS

12. The ice accretion, ice shedding and vibration characteristics of the DF antenna assemblies were evaluated throughout the test. The effect of DF antenna ice accumulation on the operation of the ECM system was not assessed. Typical ice accretions are shown in figure F-10. The excessive antenna oscillations noted in previous tests were not observed and the maximum tip amplitude recorded was generally ±2 in. occasionally increasing to ±4 in. immediately prior to an ice shed. Antenna oscillation amplitude was a function of the amount of ice accumulated rather than the rate of accretion. After flight seven, and a cumulative total of 9.5 hr icing, the forward right lower antenna element was found to be slightly loose. All DF antenna mounting screws were consequently retorqued. After flight 8, and a further 1.6 hr icing, the right forward upper element was found to be loose. The loosening of the DF antennas during flight in icing conditions is a shortcoming and is discussed further in paragraph 17. *Testing should be conducted to determine the effect of DF antenna ice accumulation on the operation of the AN/ALQ-151(V)2 countermeasures system.*

DUMMY ACTIVE DIRECTION FINDING ANTENNAS

13. The ice accretion and shedding characteristics of the dummy active DF antennas were evaluated by observation from the chase aircraft and post-flight photography throughout the tests. Ice accreted on the forward face of each antenna with a maximum thickness of approximately 1 in. at the leading edge. The ice thickness tapered to zero near the fuselage (fig. F-11). No in-flight shedding was observed and the ice formation had no adverse effect on either the antennas or the airframe. The icing characteristics of the dummy active DF antennas in the configuration tested are satisfactory.

LANDING GEAR SPONSONS

14. The ice accretion characteristics of the extended main landing gear sponson fairings were assessed throughout the test. Ice up to 3 in. thick accreted on the forward face of the sponsons (fig. C-1, app C). No in-flight shedding was observed and the ice accretion had no adverse effect on the aircraft. The icing characteristics of the extended main landing gear sponson fairings are satisfactory.

ROSEMOUNT ICING RATE METER

15. The accuracy of the Rosemount icing rate meter was evaluated throughout the tests by correlating its liquid water content (LWC) readings with the rate of ice accumulation on the visual ice accretion probe (VIAP) and, whenever possible, with calibrated LWC measurements taken by the chase JU-21A. The Rosemount LWC readings were normally significantly higher than the actual conditions throughout the tests, as illustrated by the data from flight four in table 2 below:

Table 2. Flight Four LWC Data[1,2,3,4]

Time Period (min)	VIAP LWC (g/m^3)	Rosemount LWC (g/m^3)	Time Period (min)	VIAP LWC (g/m^3)	Rosemount LWC (g/m^3)
5:45	.12	.45	4:02	.12	.70
5:25	.12	.45	5:05	.12	.75
5:28	.12	.70	9:38	.19	.25

NOTES:

[1]Flight 4 was the worst case for steady state LWC errors.
[2]Rosemount readings are averaged steady state values over the appropriate time period (transient values are ignored).
[3]Mixed icing conditions may have been present during flight 4.
[4]Indicated OAT -5.0°C, total air temperature -6.5°C throughout.

In the mixed icing conditions (combinations of supercooled liquid water drops with sleet, severe freezing drizzle or freezing rain) of flight seven, the Rosemount error was excessive with transient off-scale indications. The indications fluctuated between zero and max (2 g/m^3) and any steady indication was normally approximately double the observed (VIAP) value. The erroneous indications led the flight crew to select the BLADE DEICE MODE switch to MANUAL (MODERATE) during some phases of the flight. The rotor blade deice system, whose element off time is determined by the Rosemount when in the automatic mode, continued to operate normally throughout the flight and no adverse aircraft vibrations or excessive torque rises were noted in the light to moderate icing tested. Rosemount icing rate indications should not be used as the sole criterion for determining the severity of icing conditions since they could cause a crew to exit icing conditions less severe than indicated. The Rosemount readings should be correlated with other indications of icing severity such as torque rise and vibration level. Note that a 20% torque increase indicates that normal autorotational rotor rpm may not be attainable (ref 5, para 8-60). The inaccuracy of the Rosemount LWC readings, especially in mixed icing conditions, is a shortcoming and should be improved. As an interim measure the following sub-paragraph should be inserted into the U/EH-60A Operator's Manual at paragraph 8-60 (In-Flight Icing):

d. In mixed icing conditions (combinations of icing with sleet, freezing drizzle or freezing rain) the icing rate meter may give inaccurate indications and should not be used as the sole criterion to determine icing severity. It may not be necessary to exit mixed icing conditions unless an LWC reading of greater than 1 g/m^3 (heavy) is accompanied by a torque rise of more than 20% and/or excessive vibrations.

INTEGRATED INERTIAL NAVIGATION SYSTEM

16. The ease of operation of the IINS was assessed throughout the tests. Complete alignment took about eight minutes and could be initiated as soon as the equipment was powered up; subsequent power surges during main generator connection and hydraulic leak test system checks did not affect the alignment. IINS alignment time did not delay flights into icing conditions because of the time taken to test the de/anti-ice systems but resulted in delays of up to five minutes to other flights (the excessive length of the deice system check is a previously identified shortcoming). The usefulness of the TACAN feature of the IINS was limited by the inability to display TACAN information directly onto the flight instruments and the inability to select a desired TACAN radial using the horizontal situation indicator course knob. These two features prevent the use of the TACAN as an approach aid when no co-located VOR beacon is available. The poor integration of the IINS TACAN with the flight instruments is a shortcoming and should be improved.

RELIABILITY AND MAINTAINABILITY

Direction Finding Antenna Insulator Housings

17. Prior to the first test flight the DF antenna assemblies were installed by an engineer from Tracor Aerospace Inc. who experienced some difficulty in assembling the antenna elements into the troughs in the insulator housings. Two antenna elements subsequently worked loose, in one case after the mounting screws had been retorqued (para 12). Examination of the insulator housings showed that three screw inserts had become debonded from the housing mouldings; subsequent attempts to reseat them failed. The Tracor engineer attributed the debonding to excessive assembly pressure resulting from the tight fit of the antenna elements in the insulator housing troughs. Ice-induced oscillations then caused the antennas to 'work' in the troughs, eventually becoming loose. The loosening of the antenna elements did not constitute a safety hazard but prolonged flight with the antennas in such a loose condition could result in more serious damage and incur a risk of antenna detachment. As noted in paragraph 12, the loosening of the DF antennas is a shortcoming and the design of the insulator housings should be improved to allow easier, more consistent assembly. Maintenance procedures should be introduced to verify DF antenna security following initial installation and, until the insulator housings can be improved, after every flight in icing conditions.

Integrated Inertial Navigation System

18. The reliability of the AN/ASN-132 IINS was evaluated throughout these flight tests. During preparations for the first test flight the IINS failed and all pre-programmed information was lost; there were no indications of the failure prior to the attempted alignment. Subsequent attempts to re-align the IINS failed. IINS troubleshooting indicated that the NPU had failed and the problem was eventually rectified by reprogramming the NPU using borrowed equipment. A delay of two days was incurred during which two potential icing flights were lost. The poor reliability of the IINS has been addressed in two previous U.S. Army Aviation Engineering Flight Activity (AEFA) reports (refs 1 and 2). During a total of 135 EH-60A flight test hours performed by AEFA on various aircraft five NPU failures have been documented. Since the EH-60A is incapable of performing its mission with an inoperative IINS, the poor reliability of the NPU is a deficiency.

OPERATOR'S MANUAL AND CHECKLIST

19. Two major operator's manual and check list discrepancies were noted. The emergency procedure for 'MR DE-ICE FAULT, MR DE-ICE FAIL OR TR DE-ICE FAIL CAUTION LIGHT ON' described in reference 5 places an undue sense of urgency upon the situation by requiring the crew to land as soon as possible if vibrations increase. Reference 7 indicates that vibration increase is inevitable in the case of blade deice failure. The emergency procedure for 'MR DE-ICE FAULT, MR DE-ICE FAIL OR TR DE-ICE FAIL' should be amended as follows:

a. Icing conditions - Exit as soon as practicable.

b. BLADE DE-ICE POWER SWITCH - OFF, when out of icing conditions.

c. If icing conditions persist or excessive vibrations and/or torque rise are noted - Land as soon as practicable.

Ice shedding from the rotor blades during post-icing flight shutdown presents a significant hazard to ground personnel. The following **WARNING** should be added to reference 5 paragraph 8-60:

WARNING

> Ice shed from rotating components presents a hazard to personnel during landing and shutdown. Ground personnel should remain well clear. Passengers and crew members should not exit the helicopter until the rotor has stopped turning.

MISCELLANEOUS

20. No action had been taken to incorporate steps in the operator's and crewmember's checklist to remind pilots to activate anti-icing systems in accordance with the operator's manual. This deficiency was previously identified in paragraph 19 of reference 8.

21. Seven previously identified, icing-related shortcomings were confirmed during the test and are reiterated below, in order of decreasing importance, since no corrective action had been taken:

a. The inadequate windshield anti-ice system which does not prevent large ice accumulations on the windshields and wipers and therefore increases the probability of FOD to the helicopter due to uncontrolled shedding (para 22 of ref 8).

b. The ice accretion and shedding characteristics of the cockpit OAT indicator probes which increase the probability of engine FOD (para 24 of ref 8).

c. The large ice accretions on the wire strike protection system components which subsequently shed and could cause FOD to the aircraft (para 18 of ref 11).

d. The excessively long and complicated deice system operational check (para 44 of ref 9).

e. The insufficient main transmission drip pan capacity (para 52 of ref 9).

f. The absence of labels to indicate the reset feature of the OFF position of the windshield anti-ice switches (para 15 of ref 9).

g. The ice accumulation on the FM homing antennas which interferes with cockpit FM homing (para 36 of ref 9).

CONCLUSIONS

GENERAL

22. The EH-60A helicopter, with modified direction finding (DF) antenna insulator housings (part no. *1951-1-4116-4*), is *suitable for flight into moderate icing conditions* with the electronic countermeasures (ECM) antenna retracted only. Three deficiencies and three shortcomings were identified. Several previously identified, icing-related deficiencies and shortcomings remain uncorrected.

DEFICIENCIES

23. The following deficiencies were identified and appear in order of decreasing importance:

a. The design of the ECM antenna which permits excessive ice-induced oscillations and subsequent component failure and structural damage (paras 10 and 11).

b. The poor reliability of the navigational processing unit (NPU) associated with the AN/ASN-132 integrated inertial navigation system (IINS) (para 18).

c. The omission of steps in the operator's and crewmember's checklist to remind pilots to activate anti-icing systems in accordance with the operator's manual (para 20).

24. Two icing-related deficiencies, previously identified in references 1 and 2 were not specifically re-evaluated.

SHORTCOMINGS

25. The following shortcomings were identified and appear in order of decreasing importance:

a. The loosening of the DF dipole antennas during flight in icing conditions (paras 12 and 17).

b. The inaccuracy of the liquid water content readings of the Rosemount icing rate *meter, especially in mixed icing conditions* (para 15).

c. The poor integration of the IINS and the flight instruments which prevents the direct display of TACAN information (para 16).

26. Seven previously identified, icing-related shortcomings were re-evaluated and remain uncorrected (para 21).

27. Twenty-three icing-related shortcomings, previously identified in references 1, 2 and 5 through 11, were not specifically re-evaluated.

RECOMMENDATIONS

28. The EH-60A helicopter, with modified direction finding (DF) antenna insulator blocks (part no. 1951-1-4116-4), should be released for flight into moderate icing conditions with the electronic countermeasures (ECM) antenna retracted only (para 22).

29. The deficiency noted at paragraph 23a should be corrected prior to further icing flight tests of the EH-60A with the ECM antenna extended (paras 10 and 11).

30. The reliability of the AN/UYK-64(V) navigational processing unit associated with the AN/ASN-132 integrated inertial navigation system should be improved (para 18).

31. Steps should be included in the operator's and crewmember's checklist to remind pilots to activate anti-icing systems in accordance with the operator's manual (para 23c).

32. The shortcoming identified in paragraph 25a should be corrected by redesign of the DF dipole antenna insulator housings to permit easier and more consistent assembly (para 17).

33. Maintenance procedures should be introduced which verify the security of the DF dipole antennas after initial installation and, until the design of the insulator housings is improved, after every flight into icing conditions (para 17).

34. The accuracy of the Rosemount liquid water content (LWC) readings should be improved. As an interim measure the following sub paragraph should be added to the UH-60A Operator's Manual (ref 5) at paragraph 8-60 (In-Flight Icing):

> d. In mixed icing conditions (combinations of icing with sleet, freezing drizzle or freezing rain) the icing rate meter may give inaccurate indications and should not be used as the sole criterion to determine icing severity. It may not be necessary to exit mixed icing conditions unless an LWC reading of greater than 1 g/m^3 (heavy) is accompanied by a torque rise of more than 20% and/or excessive vibrations (para 15).

35. The integration of the TACAN with the flight instruments should be improved (para 16).

36. Testing should be conducted to determine how ice accumulations on the DF and ECM antennas affect the operation of the AN/ALQ-151(V)2 countermeasures system (paras 11 and 12).

37. The changes to the operator's manual and operator's and crewmember's checklist noted in paragraph 19 should be incorporated.

38. The seven previously identified, icing related shortcomings noted in paragraph 21 should be corrected.

APPENDIX A. REFERENCES

1. Final Report, AEFA Project No. 83-21, *Artificial and Natural Icing Tests YEH-60A Quick Fix Helicopter*, June 1984.

2. Final Report, AEFA Project No. 88-06, *Artificial and Natural Icing Tests of the EH-60A Quick Fix Helicopter*, June 1988.

3. Letter, AVSCOM, AMSAV-8, 14 December 1988, subject: Artifical and Natural Icing Test of the EH-60A Helicopter Phase II, Project No. 88-06-01 (Test Request).

4. Test Pla , AEFA Project 88-06-01, *Natural Icing Re-Evaluation of the EH-60A Quick Fix Helicopter*, 20 January 1989.

5. Technical Manual, TM 55-1520-237-10, *Operator's Manual, UH-60A and EH-60A Helicopter*, 8 January 1988. change 3 dated 12 August 1988.

6. Letter, AVSCOM, AMSAV-E, 26 February 1988, subject: Airworthiness Release for the Operation of EH-60A S/N 86-24569 for Natural Icing Re-Evaluation Testing, Revision 1, 3 February 1989.

7. Final Report, AEFA Project No. 81-18, *UH-60A Light Icing Envelope Evaluation With The Blade De-Icing Kit Installed But Inoperative*, June 1982.

8. Final Report, AEFA Project No. 87-19, *Artificial and Natural Icing Tests of the UH-60A Helicopter Configured with the XM-139 Multiple Mine Dispensing System (Volcano)*, March 1988.

9. Final Report, AEFA Project No. 79-19, *Artificial and Natural Icing Tests Production UH-60A Helicopter*, June 1980.

10. Final Report, AEFA Project No. 80-14, *Limited Artificial and Natural Icing Test Production UH-60A Helicopter (Re-Evaluation)*, August 1981.

11. Final Report, AEFA Project No. 83-22, *Limited Artificial and Natural Icing Tests of the External Stores Support System (ESSS) Installed on a UH-60A Aircraft*, June 1984.

12. Final Report, AEFA Project No. 84-23, *Artificial and Natural Icing Tests of AH-64 (Phase II)*, March 1987.

APPENDIX B. DESCRIPTION

GENERAL

1. The test aircraft, U.S. Army S/N 86-24569, is a production EH-60A fitted with the full UH-60A deicing kit (figs. B-1 through B-4). The AN/ALQ-162(V)2 radar countermeasures system had been removed and the antennas substituted by 4-1/2 in. diameter blanking plates. Four dummy active direction finding (active DF) antennas were fitted under the fuselage. Principal dimensions and characteristics of the EH-60A appear in the operator's manual (ref 5, app A). External features specific to the EH-60A which may affect ice accretion are described below.

DIRECTION FINDING ANTENNAS

2. The test aircraft was equipped with a set of four DF antenna groups, part numbers C5074121-3 and -4, mounted on the tailcone (fig. B-5) in accordance with Engineering Change Proposal 0099-E-1668R1 dated 10 February 1989. Each group comprised two 32.5 in. long, 1 in. diameter aluminum monopole antennas attached to a cross brace by means of an insulator housing (part number 1951-1-4116-4) (fig. B-6). The insulator housings were formerly machined from DELRIN material and had failed during previous icing tests (ref 2). The housings on the test aircraft were molded from 30% glass filled polyethylene terephthalate (PET) and had a revised mounting screw configuration incorporating a combination of ultrasonically injected "ultraserts" and pressed inserts (fig. B-7). The antenna elements were located in a semi-cylindrical trough in the insulator housings and retained by means of metal clamps secured by four screws locating in the inserts.

ELECTRONIC COUNTERMEASURES ANTENNA

3. The electronic countermeasures (ECM) antenna was a 109 in. long, retractable monopole mounted under the aft fuselage just forward of the tailcone. The ECM antenna was constructed of aluminum tubing whose diameter decreased from 3 in. at the base to 0.5 in. at the tip. A non-metallic insulating collar located the antenna in its mounting bracket. An electric linear actuator, part number C5074185-1, caused the antenna to extend and retract by rotating it through approximately 90 degrees about the base mounting structure (figs. B-2 and B-8). The actuator/pivot assembly had been identified as a shortcoming during previous icing tests (ref 2) and the unit fitted to the test aircraft, serial number 0014B, was an upgraded version. Specific modifications to the actuator assembly included larger diameter pivot pins, stronger pivot bushings and a more powerful linear actuator. The fuselage structure of the EH-60A was modified by the addition of a honeycomb panel underneath the transition section to which the ECM antenna actuator assembly was mounted by means of four bolts. The lower surface of the honeycomb was covered with a soft metal sheet which formed a ground plane for the antenna.

DUMMY ACTIVE DIRECTION FINDING ANTENNAS

4. Tracor Aerospace Inc. has proposed the installation of an active antenna array to replace the existing EH-60A dipole antenna array. Four dummy active DF antennas, which were externally fully representative of the actual installation, were mounted under the mid fuselage of the test aircraft for icing assessment purposes. Each plastic antenna cover was cylindrical in shape, 6 in. high and 5 in. diameter and installed on temporary mounting plates according to TRACOR drawing number 600326 (fig. B-9).

5. The positions of external antennas are shown in figure B-10.

LANDING GEAR SPONSONS

6. The main landing gear sponson fairings (part numbers 70215-02319-041 and -042) of the test aircraft were each 5 in. wider than those previously tested to accommodate 4-per-rev vibration absorbers (fig. C-1).

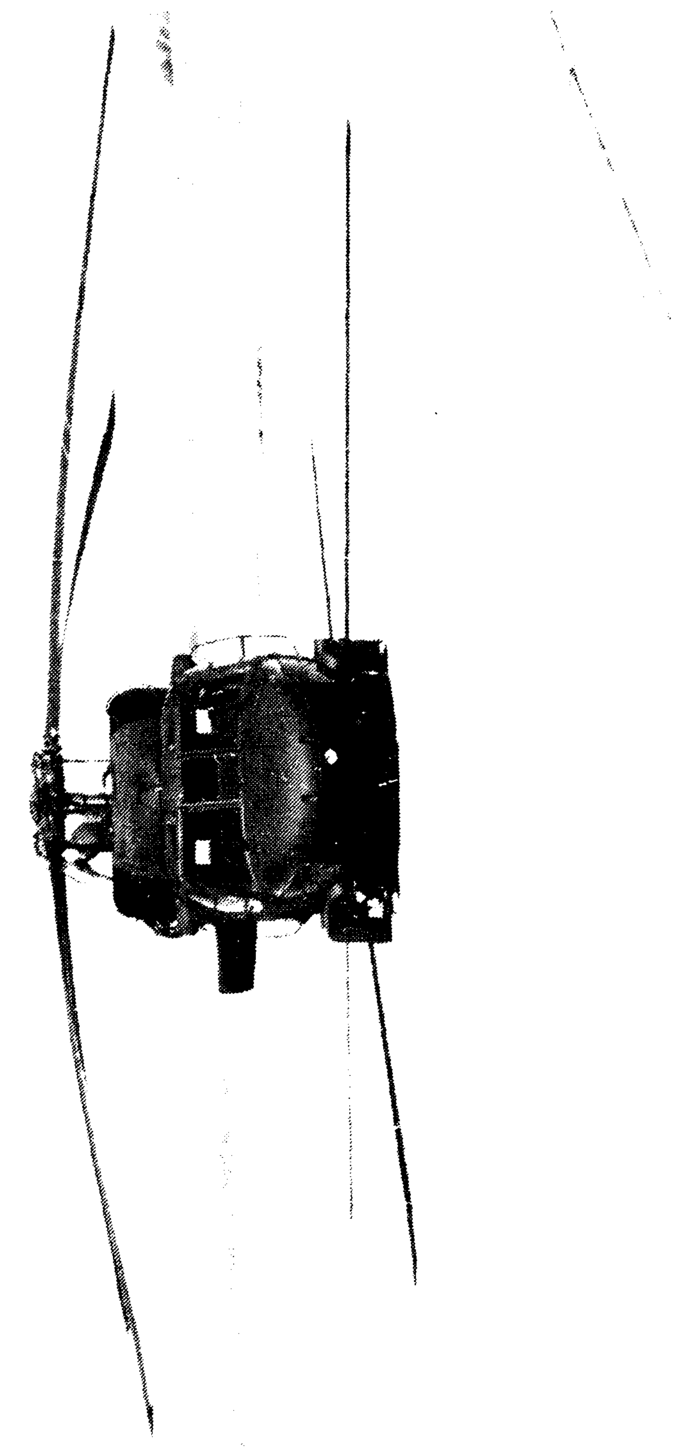


Figure B-1. Front View

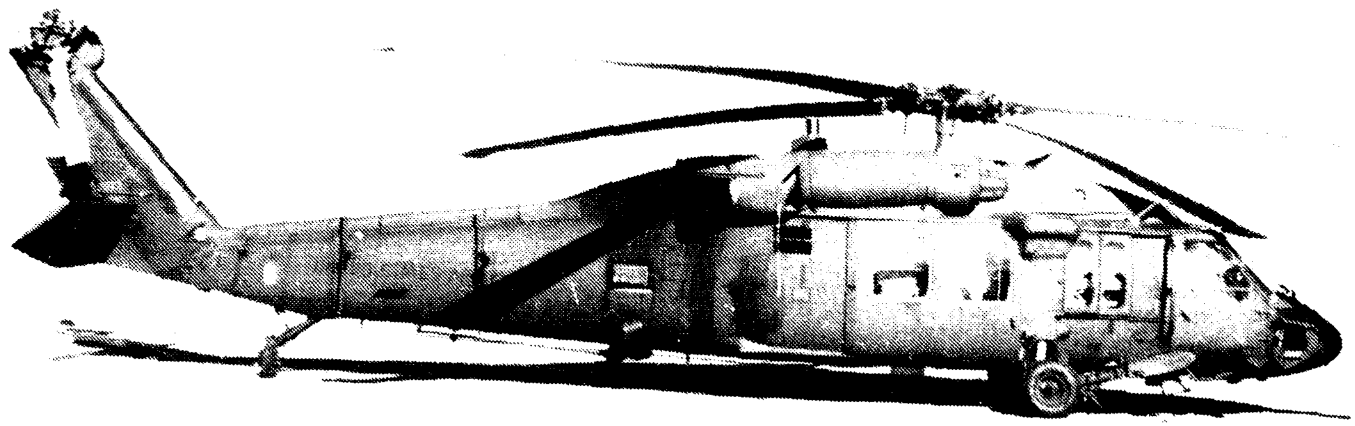


Figure B-2. Right View

Figure B-3. Left View

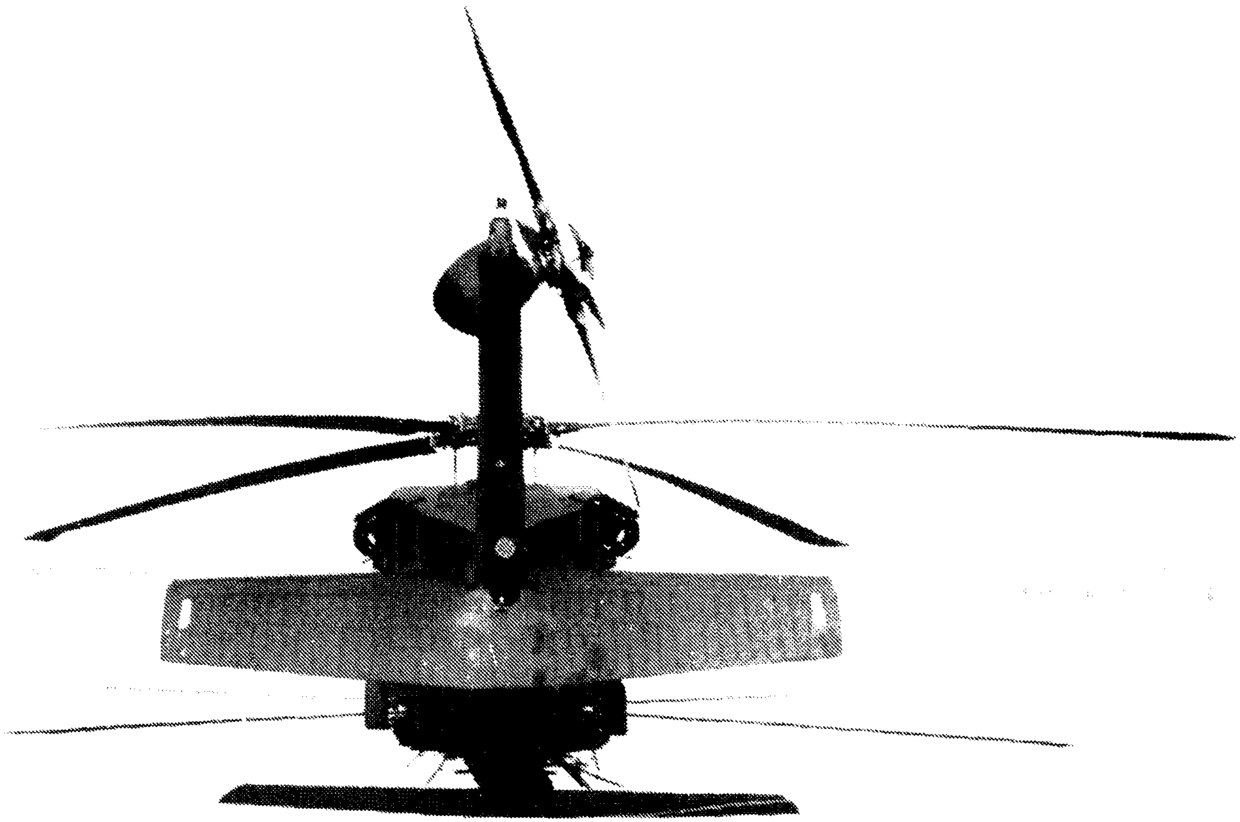


Figure B-4. Rear View

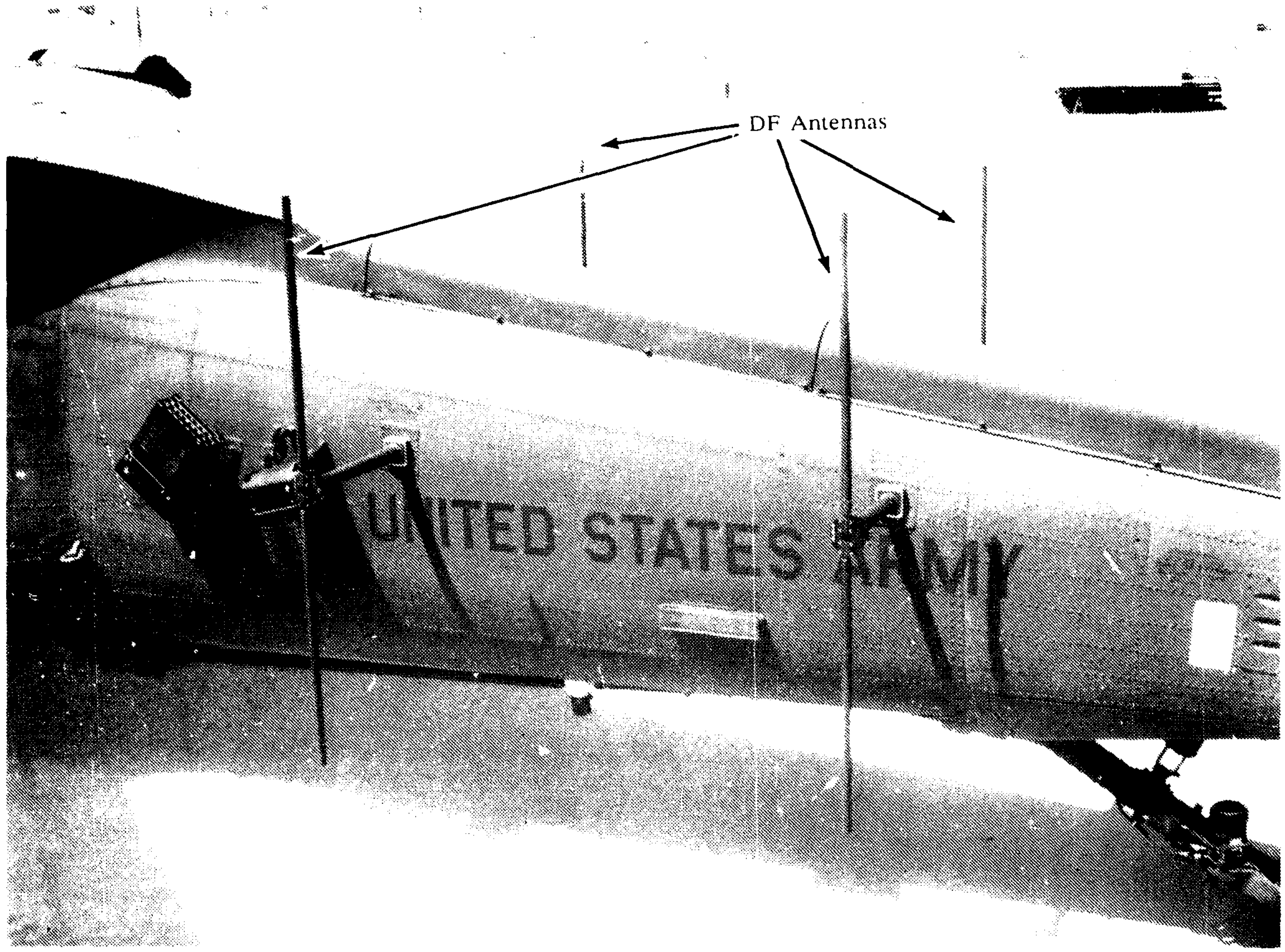


Figure B-5. Direction Finding Dipole Antennas

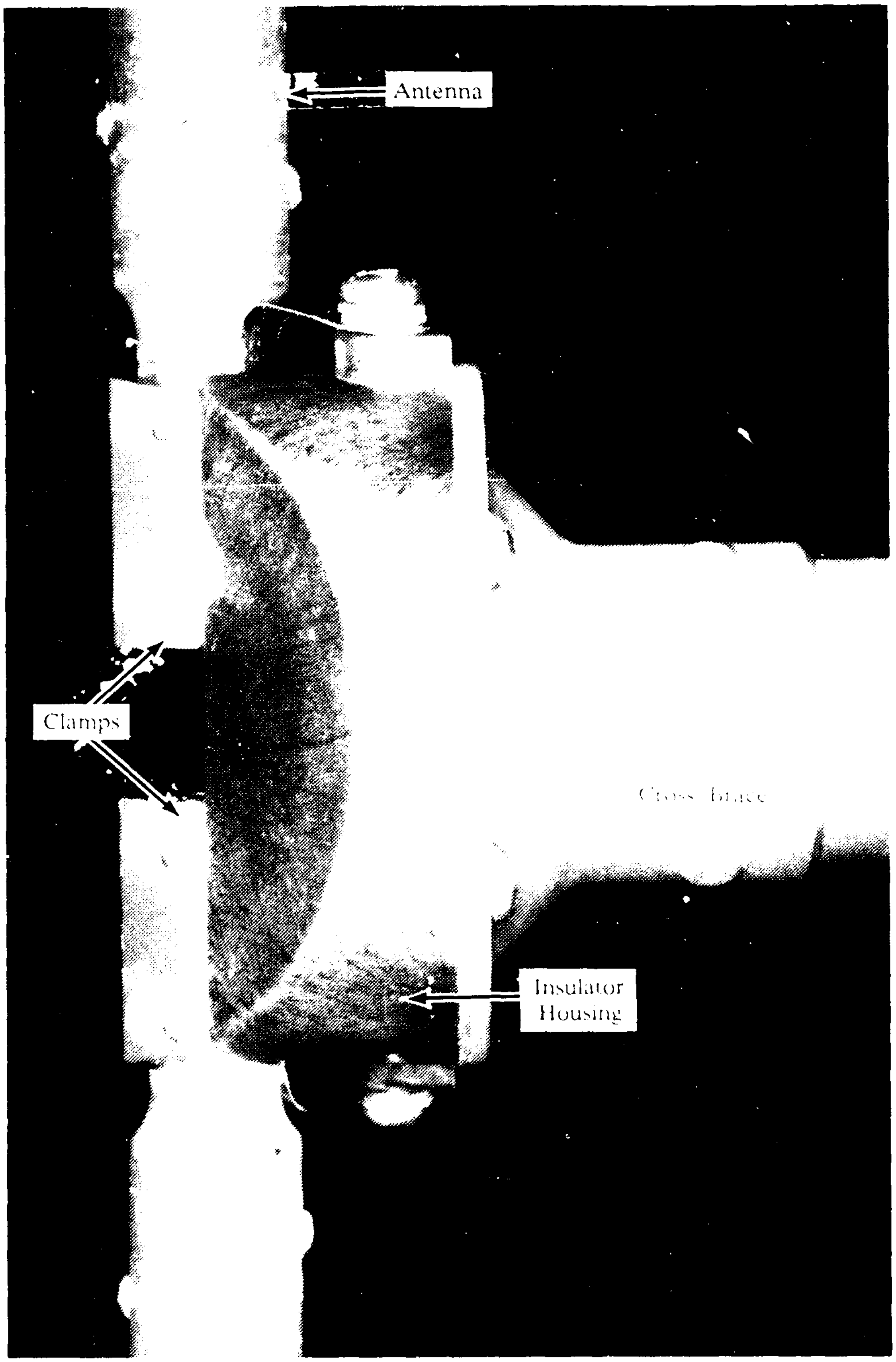


Figure B-6. Direction Finding Dipole Antenna Insulator Housing Assembly

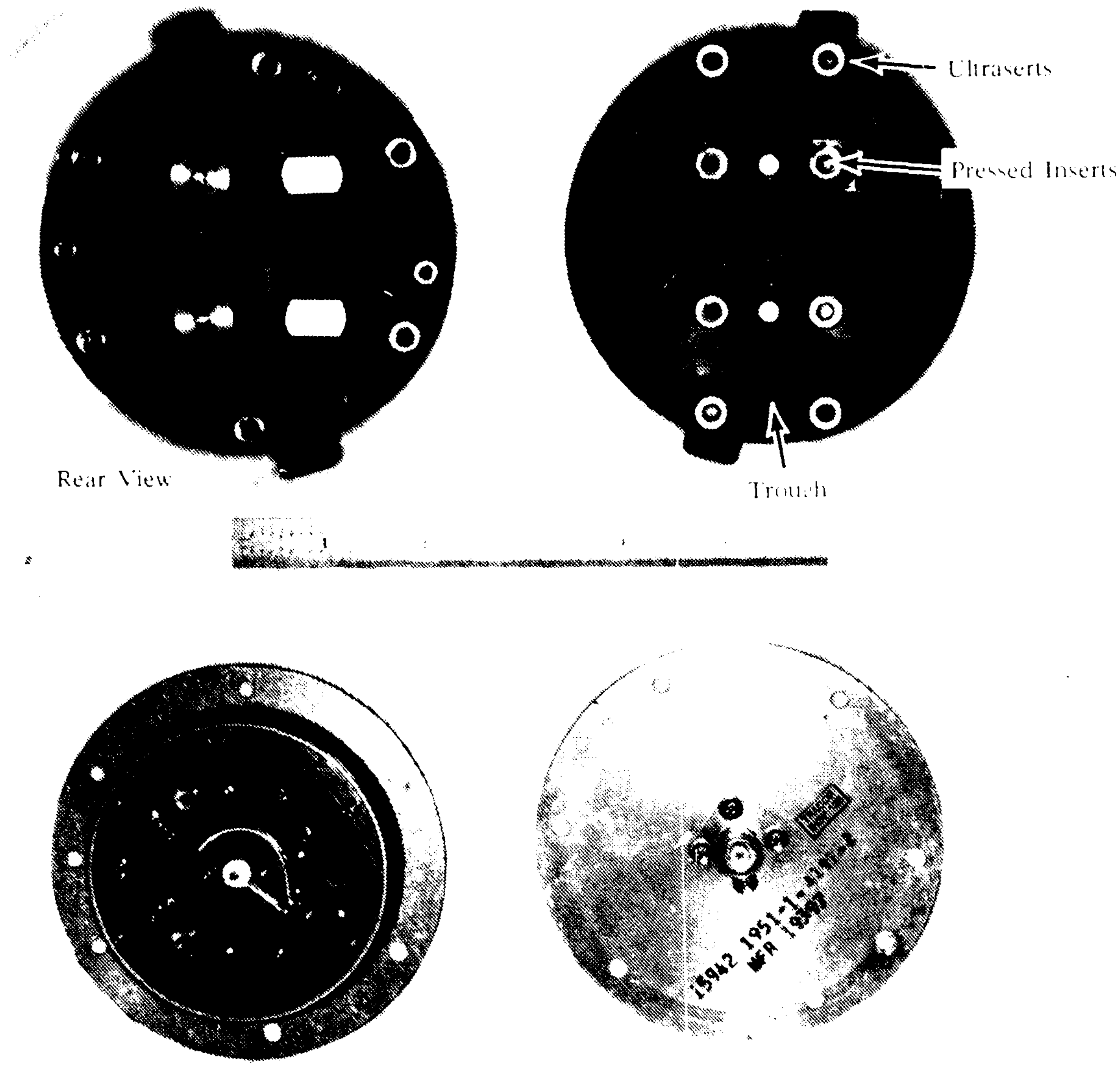
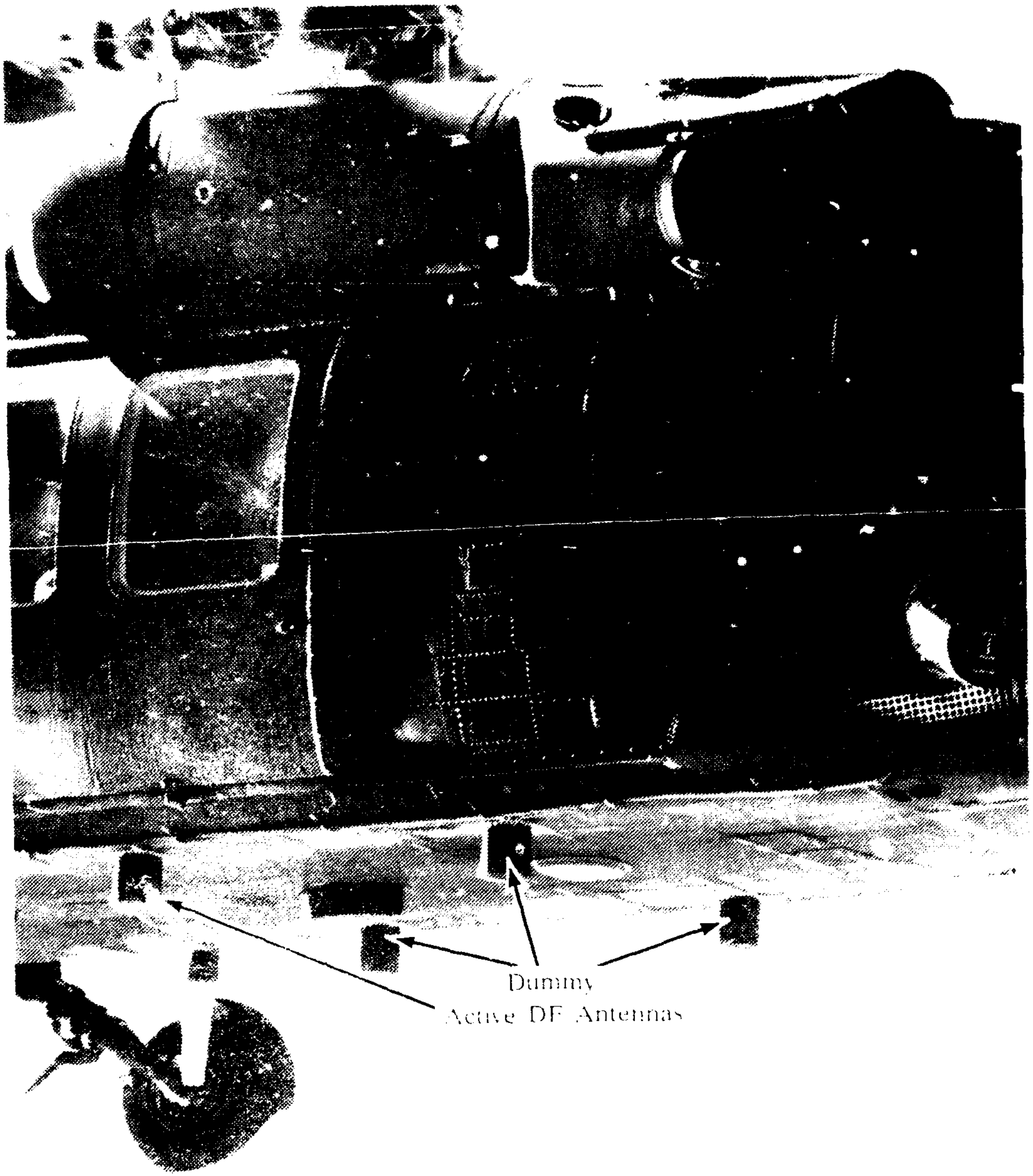


Figure B-7. Disassembled Insulator Housings



[illegible] Active Direction Finding Antennas

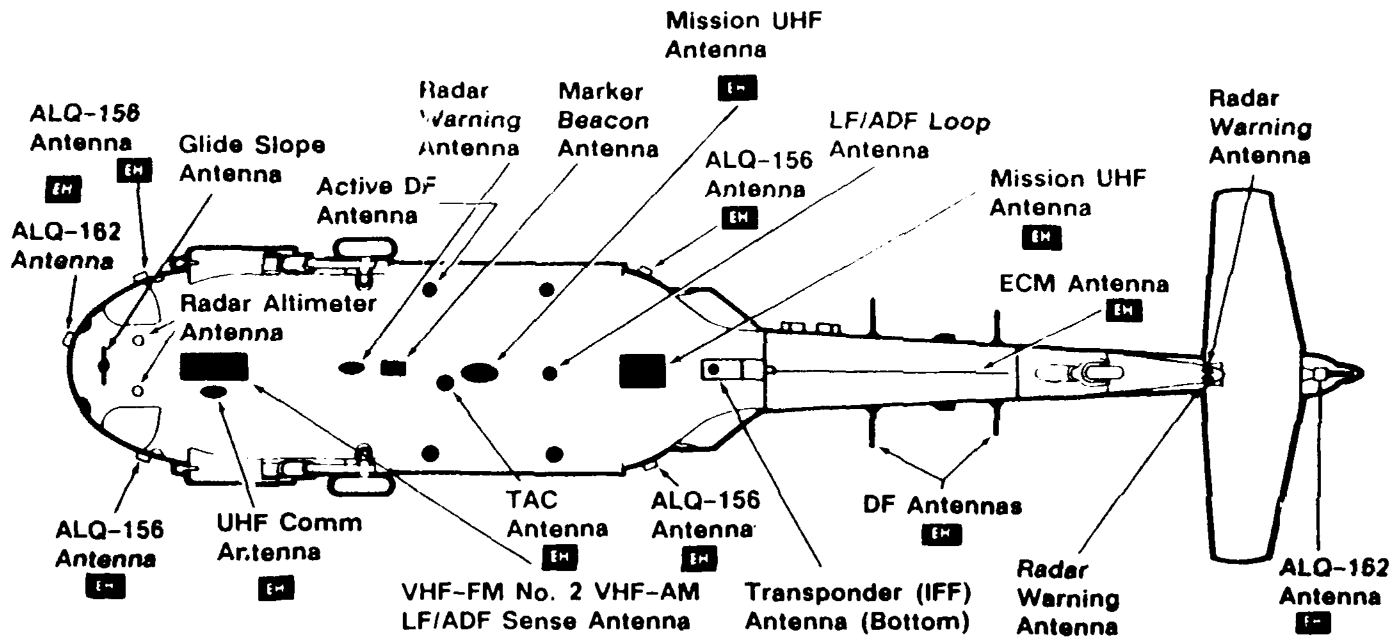


Figure B-10. Antenna Arrangement

APPENDIX C. INSTRUMENTATION

CAMERA SYSTEMS

1. A color video camera was mounted on the right side of the transition section to observe the behavior of the right side dipole antennas (fig. B-8). A second camera, mounted on the jacking point near the right hand cockpit step, recorded the motion and ice accretion of the electronic countermeasures (ECM) antenna (fig. C-1). Each camera was linked to an individual video recorder. A display mounted at the ECM operator's station could be selected to either camera output. A video camera in the chase aircraft was used to document ice accretion immediately after exiting the icing conditions. Hand held cameras were used for still photography both in the air and on the ground.

VISUAL ICE ACCRETION PROBE

2. A visual ice accretion probe (VIAP), mounted just below the left cockpit window (fig. C-2), was used to give additional visual cues of ice build up and to correlate Rosemount liquid water content (LWC) readings. The VIAP consisted of a small, symmetrical airfoil section with a rod protruding from the leading edge at mid-span; contrasting stripes on the rod were used to gauge ice thickness. The method used for deriving LWCs from VIAP measurements is described in appendix D.

CLOUD SAMPLING EQUIPMENT

3. A US Army JU-21A, S/N 66-18008, was used both as a chase aircraft and to document icing conditions using the following equipment:

a. A Particle Measuring System (PMS) comprising a FSSP-100 forward scattering spectrometer probe and an OAP-200X optical array cloud droplet spectrometer probe. The PMS was capable of sizing water droplets between 2 and 300 microns in diameter.

b. A Rosemount outside air temperature sensor and display.

c. A Cambridge model 137 chilled dew point hygrometer and display.

d. A Cloud Technology ice detector unit capable of measuring LWC in g/m^3.

e. An Aeroplane and Armament Experimental Establishment vernier ice accretion meter ("Rinaves Smith").

f. A VIAP.

g. A Small Intelligent Icing Data System (SIIDS). The SIIDS is a compact data acquisition system programmed specifically for icing studies.

Further details of the JU-21A and its equipment may be found in appendix C of reference 12.

MANUALLY RECORDED PARAMETERS

4. The following test aircraft parameters were recorded manually during icing flights:

Indicated airspeed (KT)
Engine torques (%)
Outside air temperature (deg C)
VIAP readings (in. ice)
VIAP ice accretion times (min:sec)
Rosemount LWC indications (g/m^3)

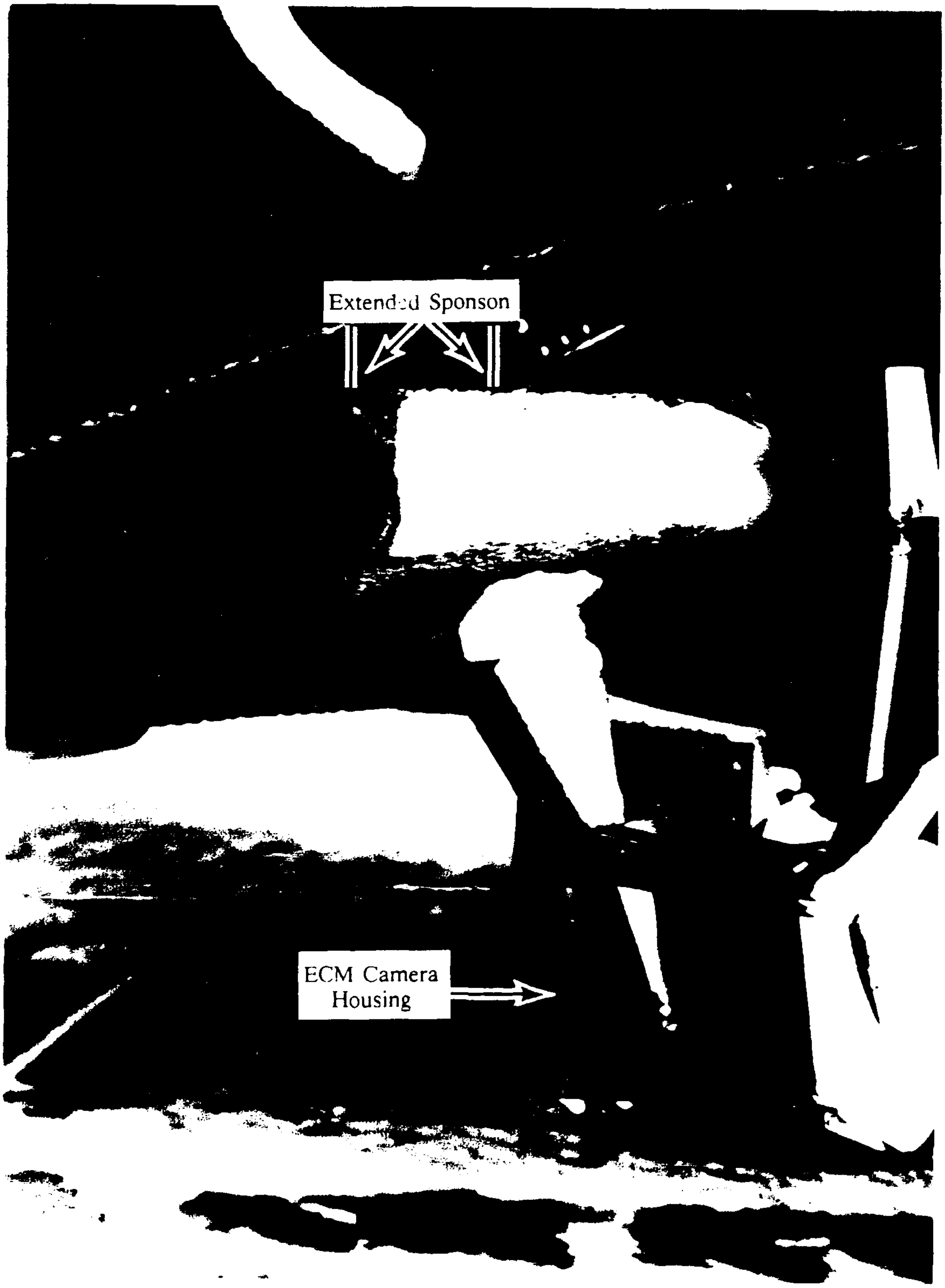


Figure C1. Main Landing Gear Sponsons/ECM Camera Housing

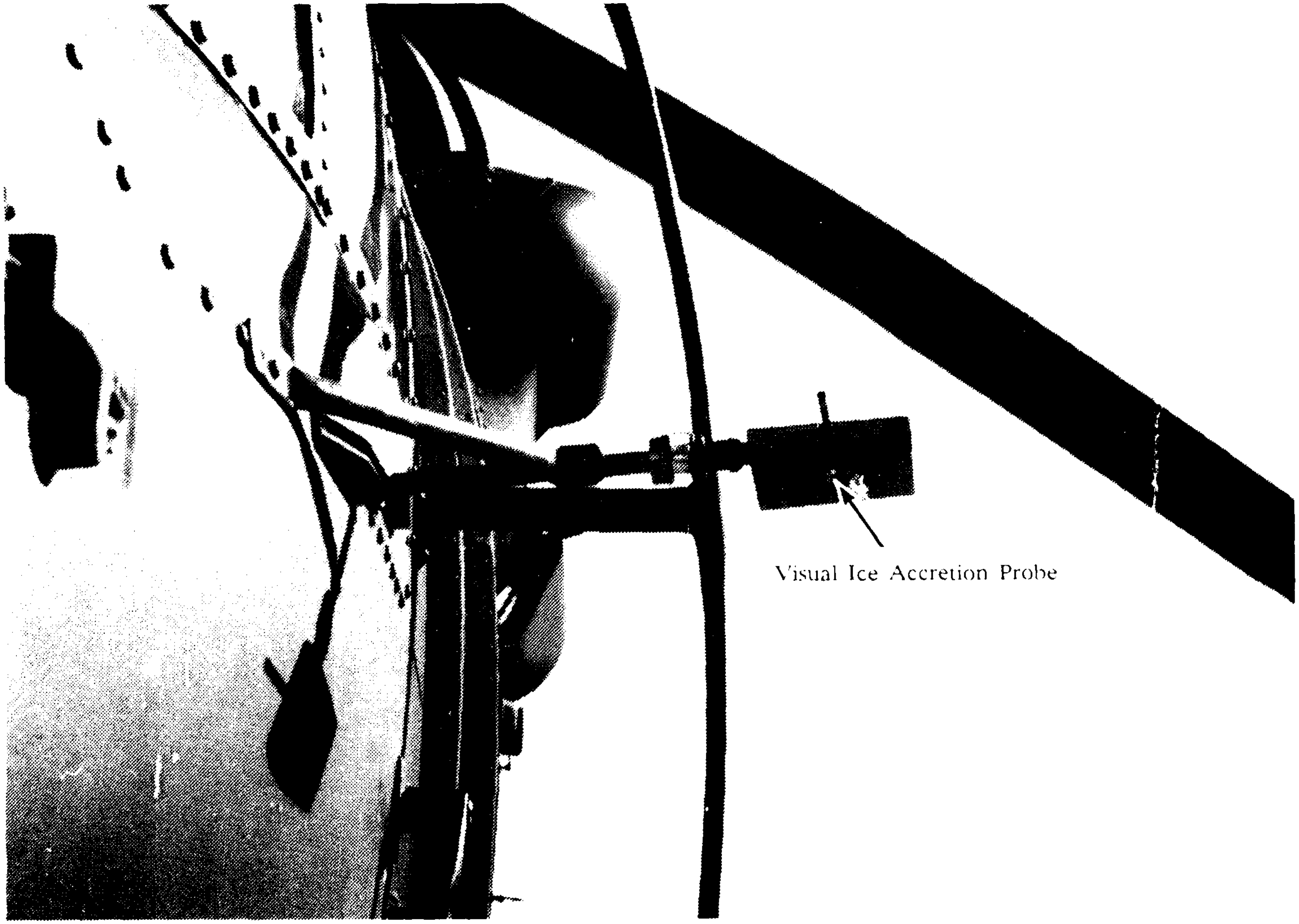


Figure C-2. Visual Ice Accretion Probe

APPENDIX D. DATA ANALYSIS METHODS AND DEFINITIONS

DATA ANALYSIS

1. Liquid water content (LWC) values were determined using figure D-1 and observed visual probe ice accretion rates. An average LWC was determined from these calculated values and those measured by the cloud sampling equipment on board the JU-21A. Calculated and measured LWCs were summed over the total samples for each flight to obtain an average. The Rosemount indicator on board the EH-60A was rarely used since the readings were inaccurate (para 15).

DEFINITIONS

2. Icing characteristics were described using the following definitions of icing severity:

a. **Trace icing:** Ice becomes perceptible. Rate of accumulation slightly greater than rate of sublimation. It is not hazardous even though deicing equipment is not used, unless encountered for an extended period of time (over 1 hour). Commonly 0 to 0.15 g/m^3 LWC for the UH-60A helicopter.

b. **Light icing:** The rate of accumulation may create a problem if flight is prolonged in this environment (over 1 hour). Occasional uses of deicing/anti-icing equipment removes/prevents accumulation. It does not present a problem if the deicing/anti-icing equipment is used. Commonly 0.15 to 0.5 g/m^3 LWC for the UH-60A helicopter.

c. **Moderate icing:** The rate of accumulation is such that even short encounters become potentially hazardous and use of deicing/anti-icing equipment or diversion is necessary. Commonly 0.5 to 1.0 g/m^3 LWC for the UH-60A helicopter.

d. **Severe/heavy icing:** The rate of accumulation is such that deicing/anti-icing equipment fails to reduce or control the hazard. Immediate diversion is necessary. Commonly greater than 1.0 g/m^3 LWC for the UH-60A helicopter.

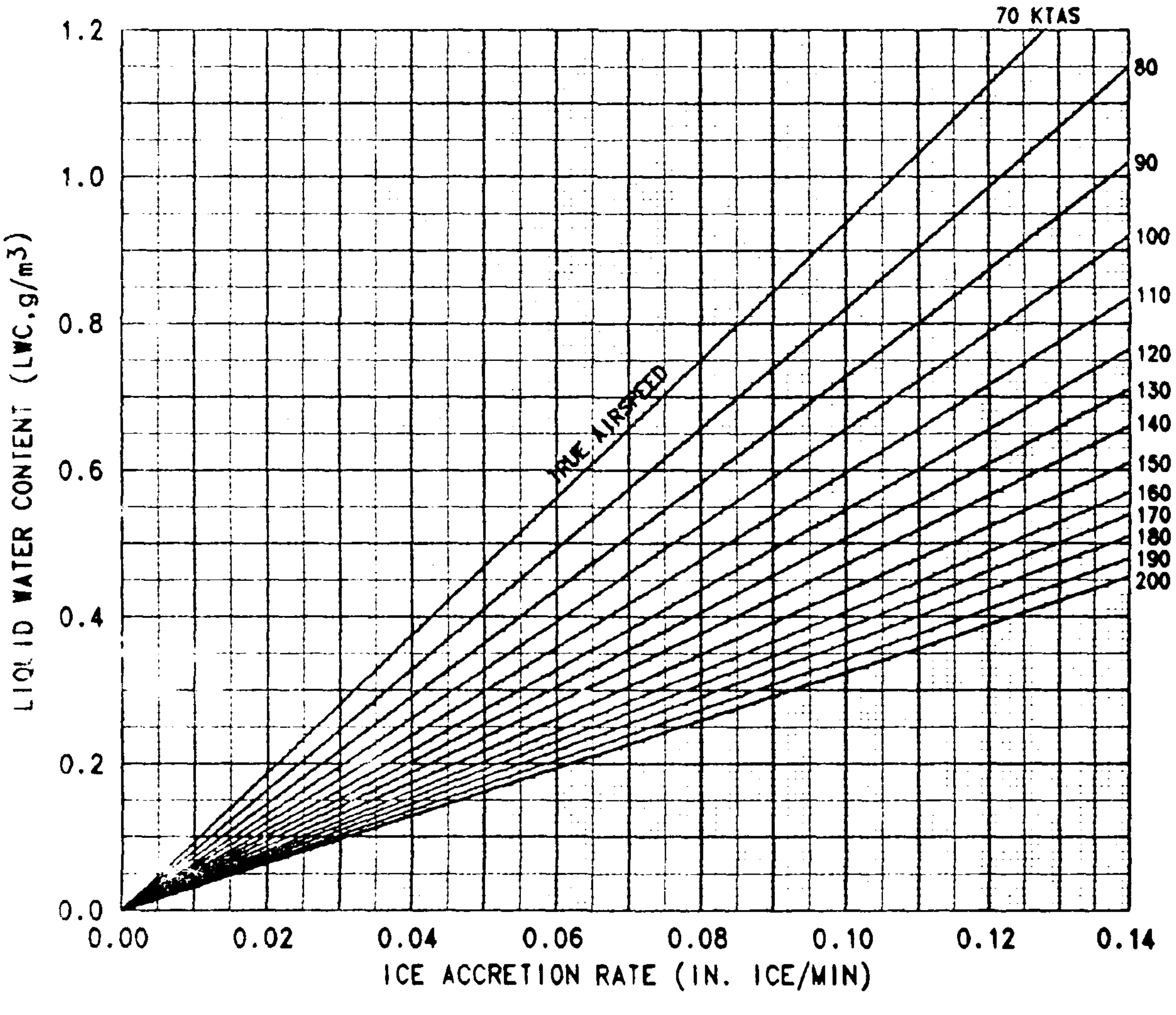
3. Results were categorized as deficiencies or shortcomings in accordance with the following definitions:

Deficiency: A defect or malfunction discovered during the life cycle of an item of equipment that constitutes a safety hazard to personnel; will result in serious damage to the equipment if operation is continued; or indicates improper design or other cause of failure of an item or part, which seriously impairs the equipment's operational capability.

Shortcoming: An imperfection or malfunction occurring during the life cycle of equipment, which must be reported and which should be corrected to increase efficiency and to render the equipment completely serviceable. It will not cause an immediate breakdown, jeopardize safe operation, or materially reduce the usability of the materiel or end product.

FIGURE D-1
CALCULATED LIQUID WATER CONTENT

NOTES: 1. COLLECTION EFFICIENCY ASSUMED TO BE 100%
2. DENSITY OF ICE = 0.8 g/cm^3
3. $LWC = \frac{(\text{ICE ACCRETION RATE})(\text{DENSITY OF ICE})}{\text{TRUE AIRSPEED}}$



APPENDIX E. TEST INCIDENT REPORTS

1. The following Test Incident Reports (TIR) were submitted during these tests:

TIR NUMBER	SUBJECT
EC-B88061001	NPU Failure
EC-B88061002	ECM Antenna/Insulation Collar De-bond
EC-B88061003	Broken Right ECM Antenna Pivot Stud
EC-B88061004	Cracked Ground Plane/Honeycomb Skin
EC-B88061005	Bent Left ECM Antenna Pivot Stud
EC-B88061006	Loose DF Antenna

TES. INCIDENT REPORT (AMCR 70-13)	1. Release Date: 2 March 1989	
2. Test Title: Natural Icing Reevaluation of the EH-60A	3. Test Project # 88-06-1	4. TIR # EC-B88061001
...ys AEFA	6. Test Sponsor AMCPM-AE	

I MAJOR ITEM DATA

AN/ASN-132 IINS	Test Life: Units:
: 9405	21. NA
	22. NA
NA	23. NA
...t#: NA	24. (Not Used)

II INCIDENT DATA

...igation Processing Unit (NPU)	40. Data & Time: 24 Feb 89, 0945
... EH-60A	41. FD/SC Step#:
...Class: Major	42. FD/SC Class:
...y: Performance	43. Chargeability: Firmware
...During: Cockpit Equip. Checks	44. Preliminary CA Status: Open
...ken: Reprogrammed	45. Asgd Resp:

...Environment: Natural Icing

...ctive Materiel: Reprogrammed/See Item 90

III INCIDENT SUBJECT DATA

Na... Navigation Processing Unit	60. FGC: EH-60A 86-24569
...al#: 151	61. LSA#:
...SN: AN/UYK-64(V)2	Part Life: Units:
ROLM	63. 358 hours
...art#: 1666 B-C	64. NA
...g#: NA	65. NA
...ity: One	66. Next Assy: AN/ASN-132(V) IINS
57. ...: Reprogrammed	67. Serial#: NA

IV MAINTENANCE DATA

...nostic Clockhours: 0.5	80. Type: Unscheduled
...gnostic Manhours: 1.0	81. Level Use: AVIM
...tive Maint Clockhours: 4.0	82. Level Prsc: AVUM
...tive Maint Manhours: 8.0	83. Level Recm: AVUM

V INCIDENT DESCRIPTION

...escription of Incident:

...rcraft has had a continuing problem with an unreliable AN/ASN-43 Gyro Magnetic ... Set. Maintenance personnel have been trouble-shooting the problem IAW procedures ...tlined in TM 11-1520-237-23-2 changes 12, Avionics Fault Isolation Procedure Manual, ...ted 30 April 79, Trouble-shooting number 11.1-3 "NPU Failure Annunciator Appears," ... 11.1-8, figure 11.1-2.

...ing the "Before starting engines, COCKPIT EQUIPMENT CHECKS," initiation of the IINS ... present position Latitude, Longitude, Magnetic Variation, Field Elevation, and (Continued)

...me, Title & Phone of Preparer:	FOR THE COMMANDER:
...EPH L. PIOTROWSKI Project Engineer, AV 527-4992	99. PAUL W. LOSIER, MAJ, AV Chief, Plans & Programs SIGNED

TEST INCIDENT REPORT (AMCP 70-13)
TIR # EC-B88061001

Item 90. (Continued)

Barometric Altimeter were input. Subsequently, a flashing "NPU" annunciator on the C11091/ASN-132(V) Control Display Unit indicated a NPU failure. The IINS was turned off for the required two minutes and then steps were taken to initiate the alignment again. Alignment was unsuccessful. IINS self-test was performed confirming the NPU failure. Subsequently, the NPU was reprogrammed with the Raymond Cassette, model 6101-01, PN 101830-602, SN 6414, and cable, model number EGPC02-PP. Two flights totalling 2.5 hours followed the reprogramming of the NPU with no failures.

INCIDENT REPORT (AMCR 70-13)	1. Release Date: 14 March 1989	
2. Test Title: Natural Icing Reevaluation of the EH-60A	3. Test Project # 88-06-1	4. TIR # EC-B88061002
5. Test Agency: AEFA	6. Test Sponsor AMCPM-AE	

I MAJOR ITEM DATA

10. Model: AS-3578/ALQ-151 (V)	Test Life: Units:
11. Serial#: 0077	21.
12. SN: NA	22.
13. Mfr: TRACOR Aerospace	23.
14. Contract#: DAAK21-84-C-0099	24. (Not Used)

II INCIDENT DATA

30. Title Debonded ECM Antenna	40. Data & Time: 7 March 1989, 1600
31. Subsystem: EH-60A	41. FD/SC Step#:
32. Incident Class: MAJOR	42. FD/SC Class:
33. Category: R&D	43. Chargeability: Hardware
34. Observed During: Post flight inspection	44. Preliminary CA Status: Open
35. Action Taken: Removed	45. Asgd Resp:

36. Test Environment: Natural Icing
37. Defective Materiel: Returned to TRACOR Aerospace

III INCIDENT SUBJECT DATA

50. Electric Countermeasures (ECM) Antenna	60. FGC: EH-60A 86-24569
51. Serial#: 0077	61. LSA#:
52. Model: AS-3578/ALQ-151 (V)	Part Life: Units:
53. Mfr: Aerospace	63.
54. Mfr Part#: C50/3926-1	64.
55. Drawing#:	65.
56. Quantity: 1	66. Next Assy:
57. Action: Removed	67. Serial#:

IV MAINTENANCE DATA

70. Diagnostic Clockhours:	80. Type: Unscheduled
71. Diagnostic Manhours:	81. Level Use: Contractor/UNK
72. Active Maint Clockhours:	82. Level Prsc: UNK
73. Active Maint Manhours:	83. Level Recm: Contractor

V INCIDENT DESCRIPTION

90. Description of Incident:

After a natural icing test flight of 1.4 hr. duration at -14.0° C with an average LWC of 0.27 g/m^3, the ECM antenna failed to fully retract. During the test flight the ECM antenna had oscillated laterally. After approximately 33 minutes, the antenna stopped oscillating and hung slightly to the right of the normal extended position.

Post flight inspection revealed a debonding between the aluminum ECM antenna and the fiberglass insulation bushing at it's base. Various patches of paint were missing from a area about 3 feet from the antenna tip. (Continued on attached sheet)

Name, Title & Phone of Preparer:	FOR THE COMMANDER:
98. JOSEPH L. PIOTROWSKI Project Engineer, AV 527-4992	99. PAUL W. LOSIER, MAJ, AV Chief, Plans & Programs

TEST INCIDENT REPORT (AMCP 70-13)
TIR # EC-B88061002

Item 90. (Continued)

Additional damage was noticed during the post flight inspection: the right ECM antenna pivot stud (TIR #EC-B88061003), the ground plane/honeycomb skin sandwich structure (TIR EC-B88061004), and the left pivot stud (TIR #EC-B88061005).

TEST I[illegible]NT REPORT (AMCR 70-13)

1. Release Date: 14 March 1989

2. Test Title: Natural Icing Reevaluation of the EH-60A

3. Test Project #: 88-06-1

4. TIR #: EC-B88061003

5. Test Agency: AEFA

6. Test Sponsor AMCPM-AE

I MAJOR ITEM DATA

10. Model: ECM Antenna Actuator Assy
11. Serial#:
12. USA#:
13. Mfr: TRACOR Aerospace
14. Contract#:

Test Life: Units:

21.
22.
23.
24. (Not Used)

II INCIDENT DATA

30. Title Sheared Pivot Switch Stud
31. Subsystem:
32. Incident Class: MAJOR
33. Category: R&D
34. Observed During: Post flight inspection
35. Action Taken: Removed

40. Data & Time: 7 March 1989, 1600
41. FD/SC Step#:
42. FD/SC Class:
43. Chargeability: Hardware
44. Preliminary CA Status: Open
45. Asgd Resp:

48. Test Environment: Natural Icing
49. Defective Materiel: Returned to TRACOR Aerospace

III INCIDENT SUBJECT DATA

50. Name Stud, Pivot Switch
51. Serial#:
52. FSN/NSN:
53. Mfr: TRACOR Aerospace
54. Mfr Part#: 57958/C5074731
55. Drawing#: 3099-E-1449R2C1
56. Quantity: 1
57. Action: Removed

60. FGC: EH-60A, 86-24569
61. LSA#:

Part Life: Units:

63.
64.
65.
66. Next Assy: Actuator Assy
67. Serial#:

IV MAINTENANCE DATA

70. Diagnostic Clockhours:
71. Diagnostic Manhours:
72. Active Maint Clockhours:
73. Active Maint Manhours:

80. Type: Unscheduled
81. Level Use: Contractor/UNK
82. Level Prsc: UNK
83. Level Recm: Contractor

V INCIDENT DESCRIPTION

Full Description of Incident:

[illegible] At the completion of a natural icing test flight of 1.4 hr. duration, -14.0° C and with an average LWC of 0.27 g/m^3, a post flight inspection revealed a broken right pivot stud on the ECM antenna actuator assembly. In the area of the sheared stud, damage was also apparent on the actuator mounting/housing and the moveable antenna mounting plate.

Additional damage was noticed during the post flight inspection: the ECM antenna (TIR #EC-B88061002), the ground plane/honeycomb skin sandwich structure (TIR #EC-B88061004), and the left pivot stud (TIR #EC-B88061005).

Name, Title & Phone of Preparer:

98. JOSEPH L. PIOTROWSKI
Project Engineer, AV 527-4992

FOR THE COMMANDER:

99. PAUL W. LOSIER, MAJ, AV
Chief, Plans & Programs

TEST INCIDENT REPORT (AMCR 70-13)	1. Release Date: 14 March 1989
2. Test Title: Natural Icing Reevaluation of the EH-60A	3. Test Project # 88-06-1 — 4. TIR # EC-B88061004
5. Test Agency: AEFA	6. Test Sponsor AMCPM-AE

I MAJOR ITEM DATA

10. Model: Helicopter, EH-60A	Test Life: Units:
11. Serial#: 86-24569	21.
12. USA#:	22.
13. Mfr: Sikorsky	23.
14. Contract#:	24. (Not Used)

II INCIDENT DATA

30. Title Cracked Ground Plane	40. Data & Time: 7 March 1989, 1600
31. Subsystem:	41. FD/SC Step#:
32. Incident Class: MAJOR	42. FD/SC Class:
33. Category: R&D	43. Chargeability: Hardware
34. Observed During: Post flight inspection	44. Preliminary CA Status: Open
35. Action Taken: Stop Drilled	45. Asgd Resp:

48. Test Environment: Natural Icing
49. Defective Materiel: See Item 90.

III INCIDENT SUBJECT DATA

50. Name Ground Plane	60. FGC:
51. Serial#:	61. LSA#:
52. FSN/NSN:	Part Life: Units:
53. Mfr: TRACOR Aerospace	63.
54. Mfr Part#:	64.
55. Drawing#: 601186	65.
56. Quantity: 1	66. Next Assy: Honeycomb skin
57. Action: Inspected	67. Serial#:

IV MAINTENANCE DATA

70. Diagnostic Clockhours:	80. Type: Unscheduled
71. Diagnostic Manhours:	81. Level Use: Contractor/UNK
72. Active Maint Clockhours:	82. Level Prsc: AVUM
73. Active Maint Manhours:	83. Level Recm: Contractor/UNK

V INCIDENT DESCRIPTION

90. Description of Incident:

At the completion of a natural icing test flight of 1.4 hr. duration at -14.0° C and with an average LWC of 0.27 g/m^3, post flight inspection revealed a cracked ground plane and honeycomb skin. The ground plane and honeycomb skin form a sandwich structure which [illegible] the ECM antenna actuator assembly. The structure is located at a fuselage station [illegible], water line of 202.53, and buttline of 0, underneath the transition section.

Additional damage was noticed during the psot flight inspection: the ECM antenna (TIR [illegible]), the right pivot switch stud (TIR #EC-B88061003), and the left pivot stud (Cont)

Name, Title & Phone of Preparer: [illegible] PIOTROWSKI, Project Engineer, AV 527-4992	FOR THE COMMANDER: 99. PAUL W. LOSIER, Chief, Plans & Programs

TEST INCIDENT REPORT (AMCP 70-13)
TIR #EC-B88061004

Item 90. (Continued)

(TIR #EC-B88061005).

Item 49.

Structure will remain installed on the aircraft. After testing, aircraft will be returned to Flight Systems Inc., a subcontractor of TRACOR Aerospace.

TEST INCIDENT REPORT (AMCR 70-13)	1. Release Date: 14 March 1989	
2. Test Title: Natural Icing Reevaluation of the EH-60A	3. Test Project #: 88-06-1	4. TIR #: EC-B88061005
5. Test Agency: AEFA	6. Test Sponsor: AMCPM-AE	

I MAJOR ITEM DATA

10. Model: ECM Antenna Actuator Assy	Test Life: Units:
11. Serial#:	21.
12. USA#:	22.
13. Mfr: TRACOR Aerospace	23.
14. Contract#:	24. (Not Used)

II INCIDENT DATA

30. Title Bent Pivot Stud	40. Data & Time: 7 March 1989, 1600
31. Subsystem:	41. FD/SC Step#:
32. Incident Class: MAJOR	42. FD/SC Class:
33. Category: R&D	43. Chargeability: Hardware
34. Observed During: Post flight inspection	44. Preliminary CA Status: Open
35. Action Taken: Removed	45. Asgd Resp:

36. Test Environment: Natural Icing
37. Defective Materiel: Returned to TRACOR Aerospace

III INCIDENT SUBJECT DATA

50. Name Stud, Pivot	60. FGC: EH-60A 86-24569
51. Serial#:	61. LSA#:
52. FSN/NSN:	Part Life: Units:
53. Mfr: TRACOR Aerospace	63.
54. Mfr Part#: 57958/C5074725	64.
55. Drawing#: 0099-E-1449R2C1	65.
56. Quantity: 1	66. Next Assy: Actuator Assy
57. Action: Removed	67. Serial#:

IV MAINTENANCE DATA

70. Diagnostic Clockhours:	80. Type: Unscheduled
71. Diagnostic Manhours:	81. Level Use: Contractor/UNK
72. Active Maint Clockhours:	82. Level Prsc: UNK
73. Active Maint Manhours:	83. Level Recm: Contractor

V INCIDENT DESCRIPTION

Full Description of Incident:

90. At the completion of a natural icing test flight of 1.4 hr. duration at -14.0° C and with an average LWC of 0.27 g/m^3, a post flight inspection revealed a bent left ECM antenna pivot stud.

Additional damage was noticed during the post flight inspection: the ECM antenna (TIR #EC-B88061002), the ground plane/honeycomb skin sandwich structure (TIR #EC-B88061004), and the right pivot switch stud (EC-B88061003).

Name, Title & Phone of Preparer:	FOR THE COMMANDER:
98. JOSEPH L. PIOTROWSKI Project Engineer, AV 527-4992	99. PAUL W. LOSIER Chief, Plans & Programs

TEST INCIDENT REPORT (AMCR 70-13)

TEST INCIDENT REPORT (AMCR 70-13)	1. Release Date: 16 March 1989	
2. Test Title: Natural Icing Reevaluation of the EH-60A	3. Test Project # 88-06-1	4. TIR # EC-B88061006
5. Test Agency: AEFA	6. Test Sponsor AMCPM-AE	

I MAJOR ITEM DATA

10. Model: Antenna, Direction Finding (DF)	Test Life: Units:
11. XXXXXXXX MFR PART #. C5074121-3	21. 29.1 hours
12. USA#:	22.
13. Mfr: TRACOR Aerospace	23.
14. Contract#:	24. (Not Used)

II INCIDENT DATA

30. Title Loose Monopole Antenna	40. Data & Time: 13 March 1989, 1200
31. Subsystem: EH-60A	41. FD/SC Step#:
32. Incident Class: Minor	42. FD/SC Class:
33. Category: R&D	43. Chargeability: Hardware
34. Observed During: Post flight inspection	44. Preliminary CA Status: Open
35. Action Taken: Removed	45. Asgd Resp:

48. Test Environment: Natural Icing
49. Defective Materiel:

III INCIDENT SUBJECT DATA

50. Name Housing Insulator	60. FGC: EH-60A, 86-24569
51. Serial#:	61. LSA#:
52. FSN/NSN:	Part Life: Units:
53. Mfr: TRACOR Aerospace	63. 29.1 hours
54. Mfr Part#: 1951-1-4116-4	64.
55. Drawing#:	65.
56. Quantity: 1	66. Next Assy: Housing Ins. & D.F. Antenna
57. Action:	67. Serial#: CS074124

IV MAINTENANCE DATA

70. Diagnostic Clockhours: 0.5	80. Type: Unscheduled
71. Diagnostic Manhours: 1	81. Level Use: Contractor/UNK
72. Active Maint Clockhours: 1	82. Level Prsc: UNK
73. Active Maint Manhours: 2	83. Level Recm: Contractor

V INCIDENT DESCRIPTION

91 Description of Incident:

After the completion of a natural icing flight at LWC=0.33 g/m^3 and a temperautre of [illegible], the #2 upper monopole antenna was found loose. The housing insulator was disassembled revealing a screw insert that was not aligned correctly within its retaining shoulders. The insert was skewed approximately 20 degrees and was lodged on top of the shoulders. The location of this insert was for the upper monopole element's lower screw hole.

(Continued on attached sheet)

Name, Title & Phone of Preparer:	FOR THE COMMANDER:
98. JOSEPH L. PIOTROWSKI Project Engineer, AV 527-4992	99. PAUL W. LOSIER, MAJ, AV Chief, Plans & Programs

TEST INCIDENT REPORT (AMCR 70-13)
TIR #EC-B88061006

Item 90. (Continued)

The remaining 3 housing insulators were inspected. Inspection of the #3 dipole housing insulator revealed a 1/64" gap between two screw inserts and their respective retaining shoulder channels. The gap between the insulator and the retaining shoulder channel was not sufficient to permit the screw inserts to rotate. The two remaining housing insulators on the left hand side of the aircraft were undamaged.

For further details, see advanced copy/final report, AEFA Project No. 88-06-1.

APPENDIX F. PHOTOGRAPHS

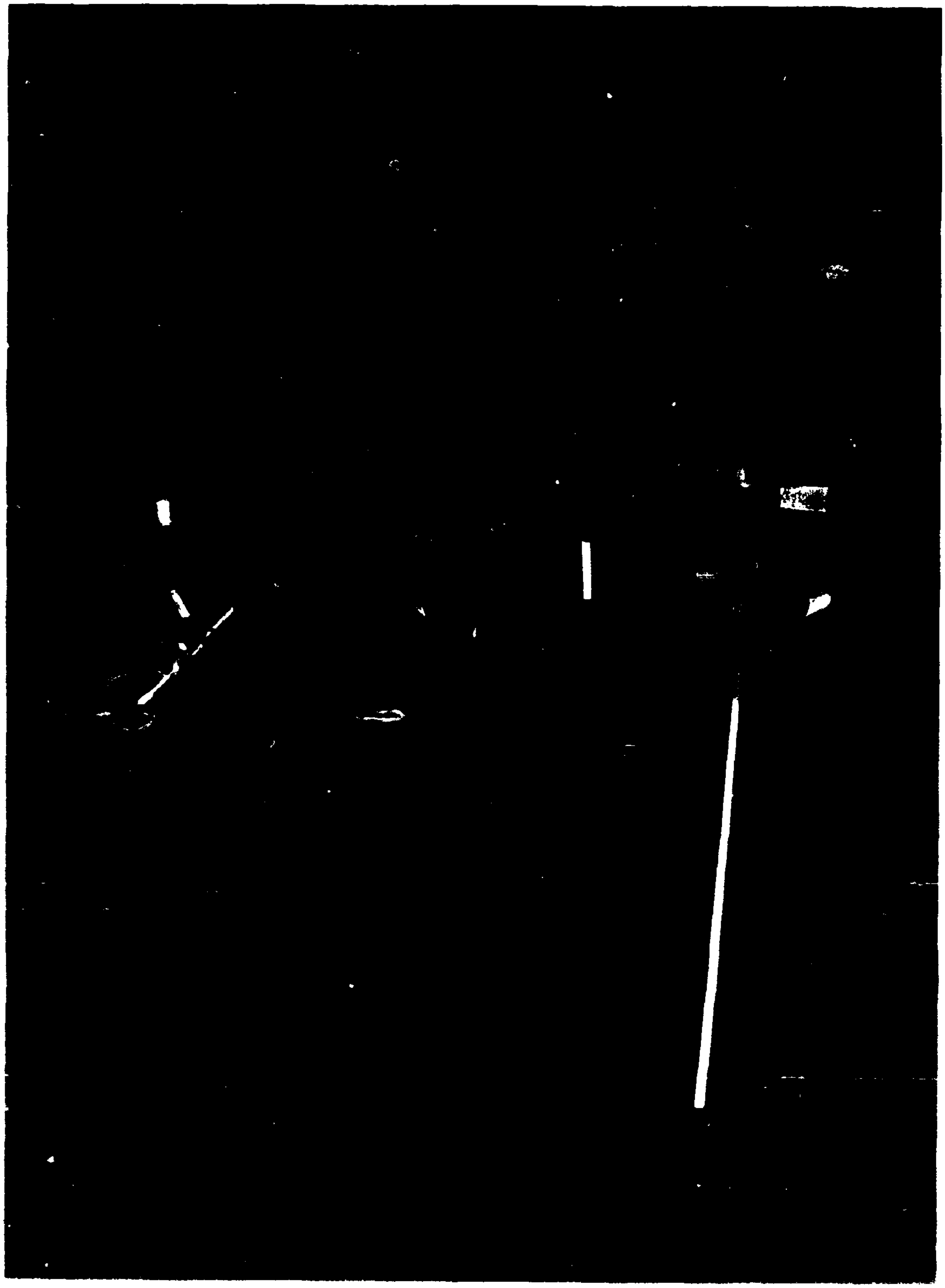


Figure F-1. Typical ECM Antenna Ice Accretion (Flight #1)

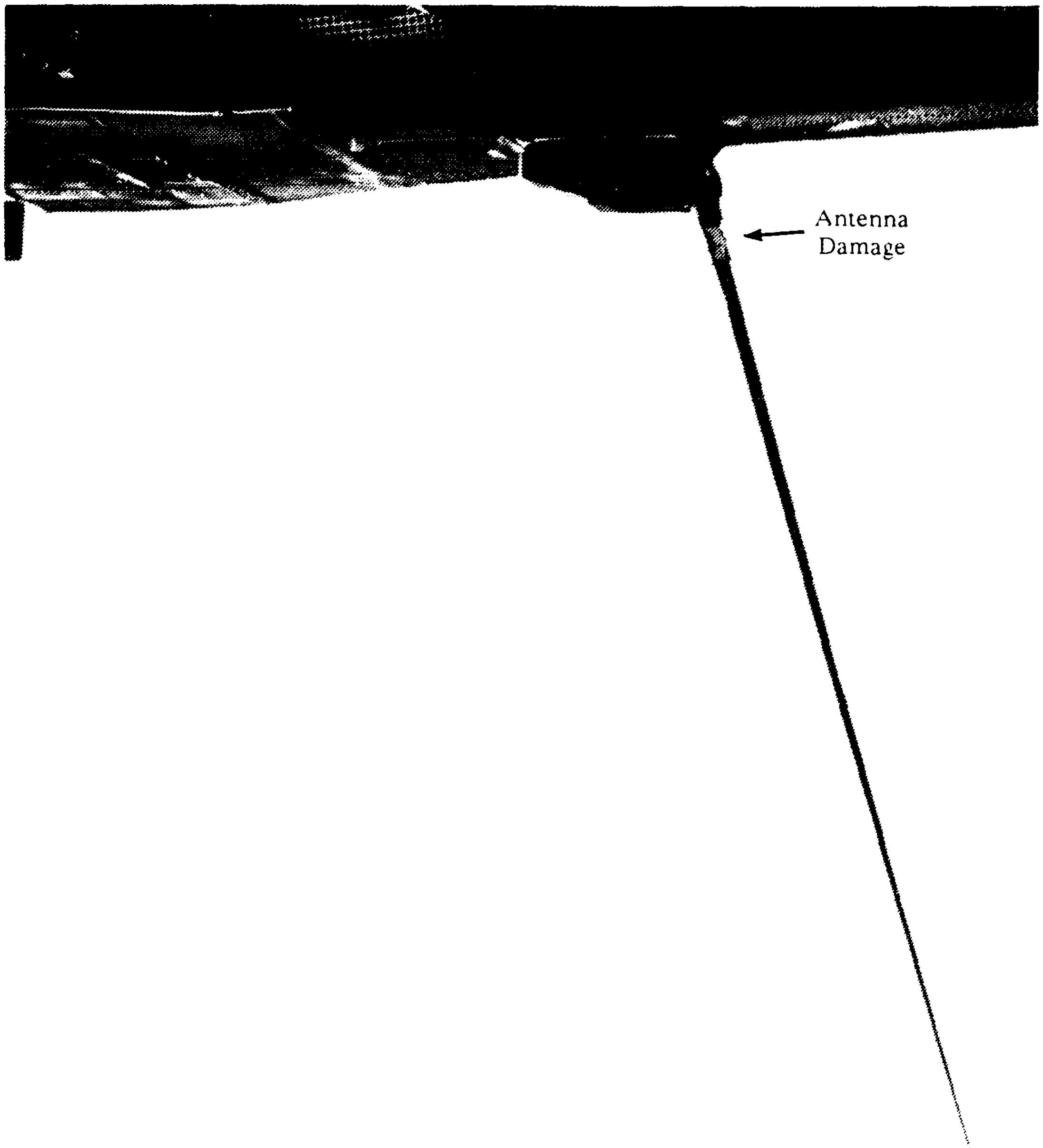


Figure F-2. ECM Antenna Extended Post-Failure (Flight #3)

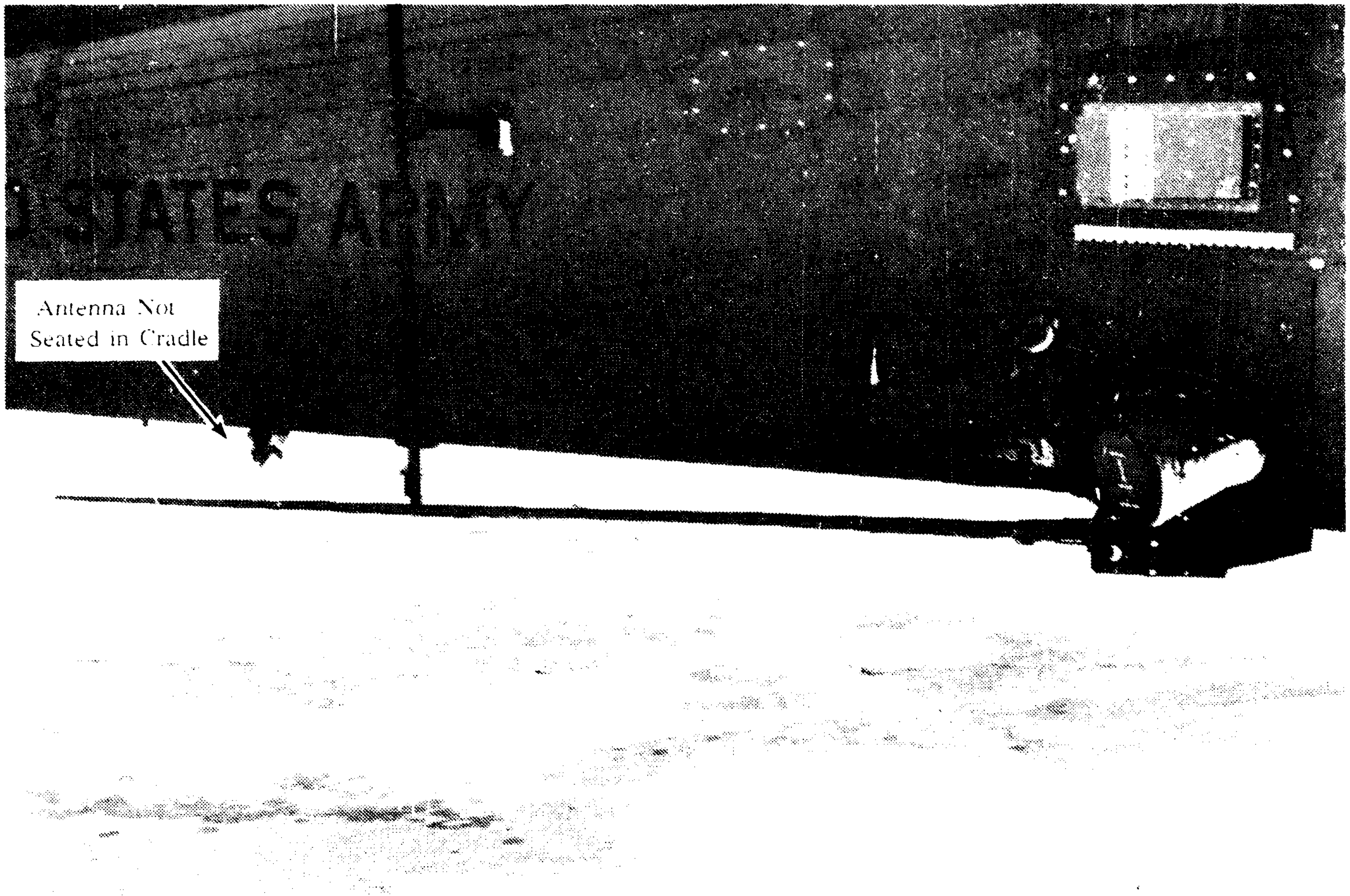


Figure F-3. ECM Antenna Retracted Post-Failure

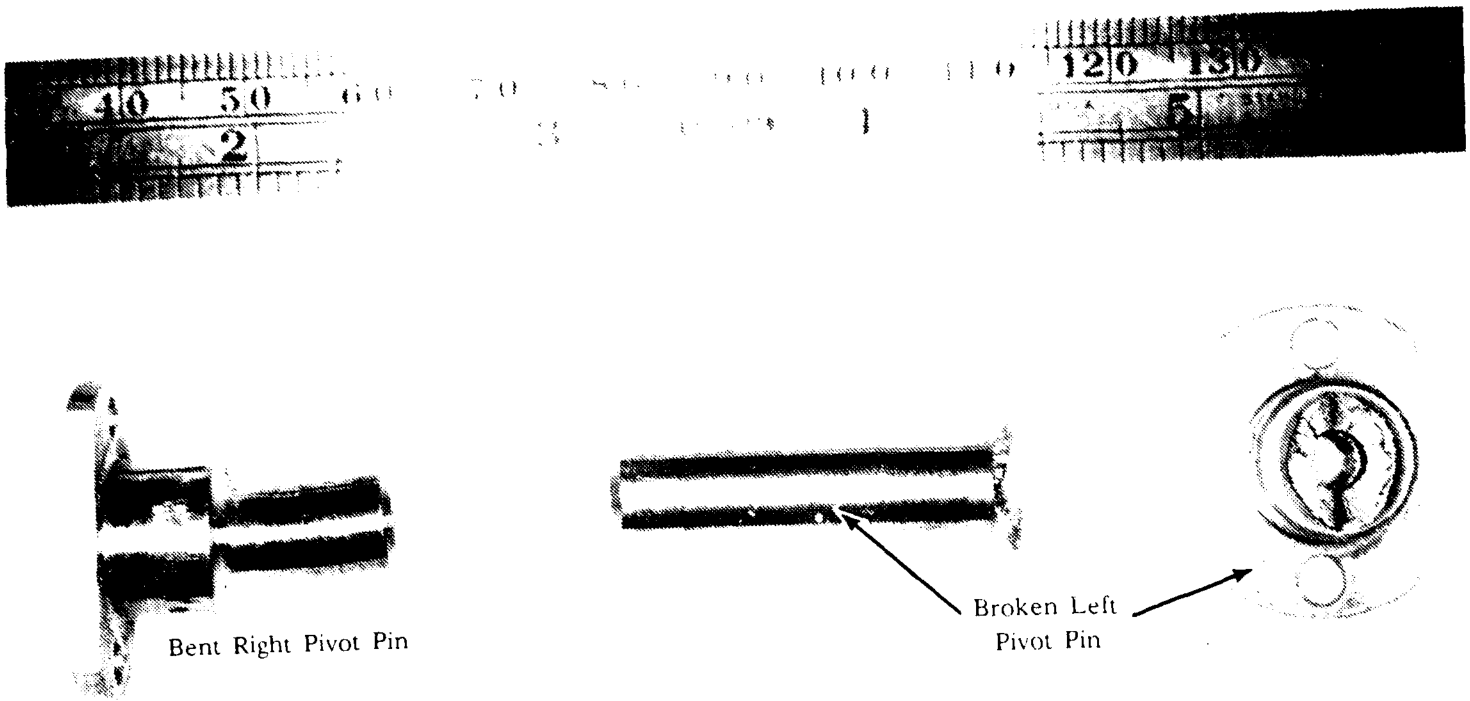


Figure F-4. Damaged ECM Antenna Pivot Pins

Figure F-5. Damaged ECM Antenna Mounting Structure

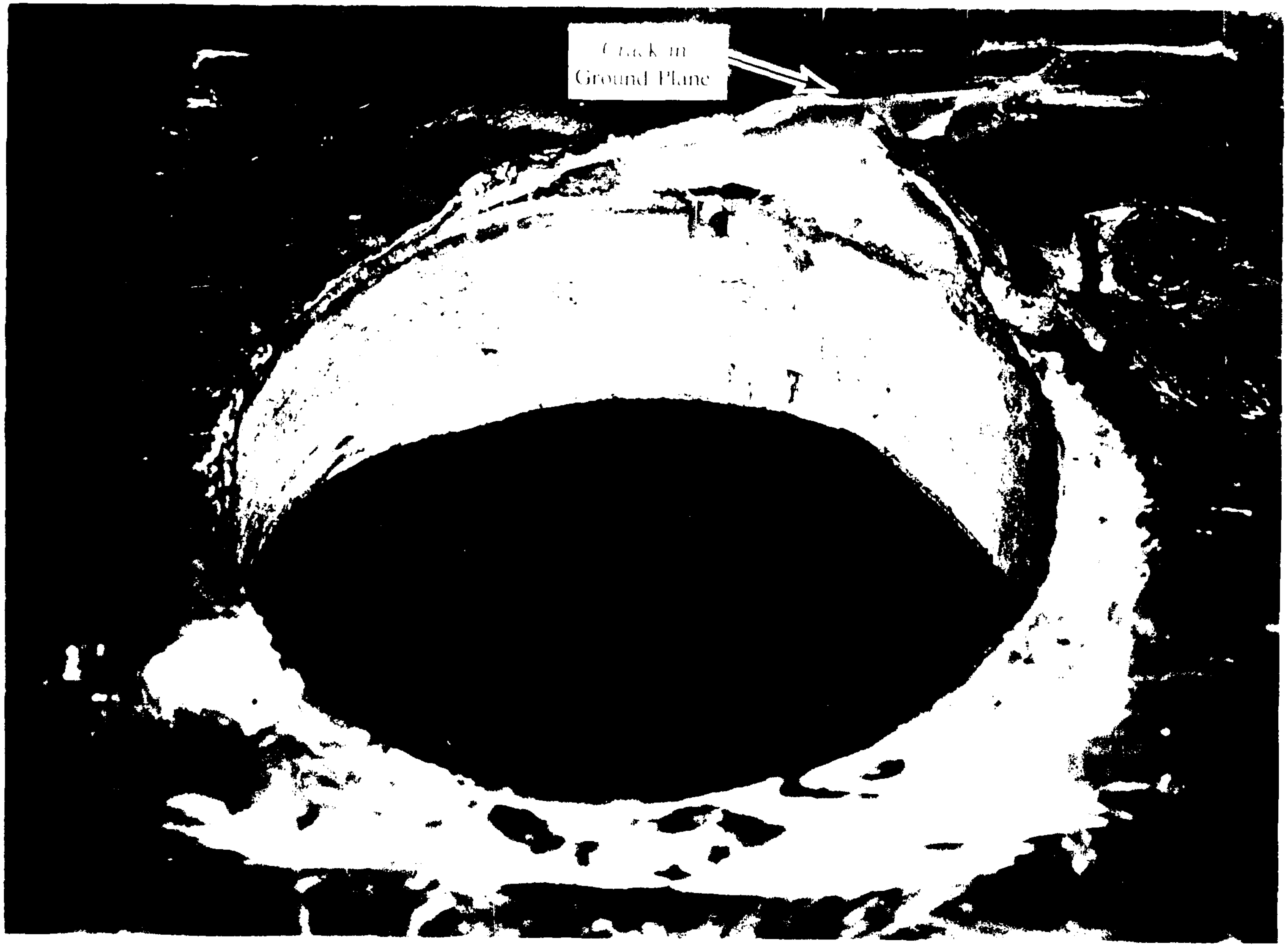


Figure E-6 Damaged FCM Antenna Ground Plane

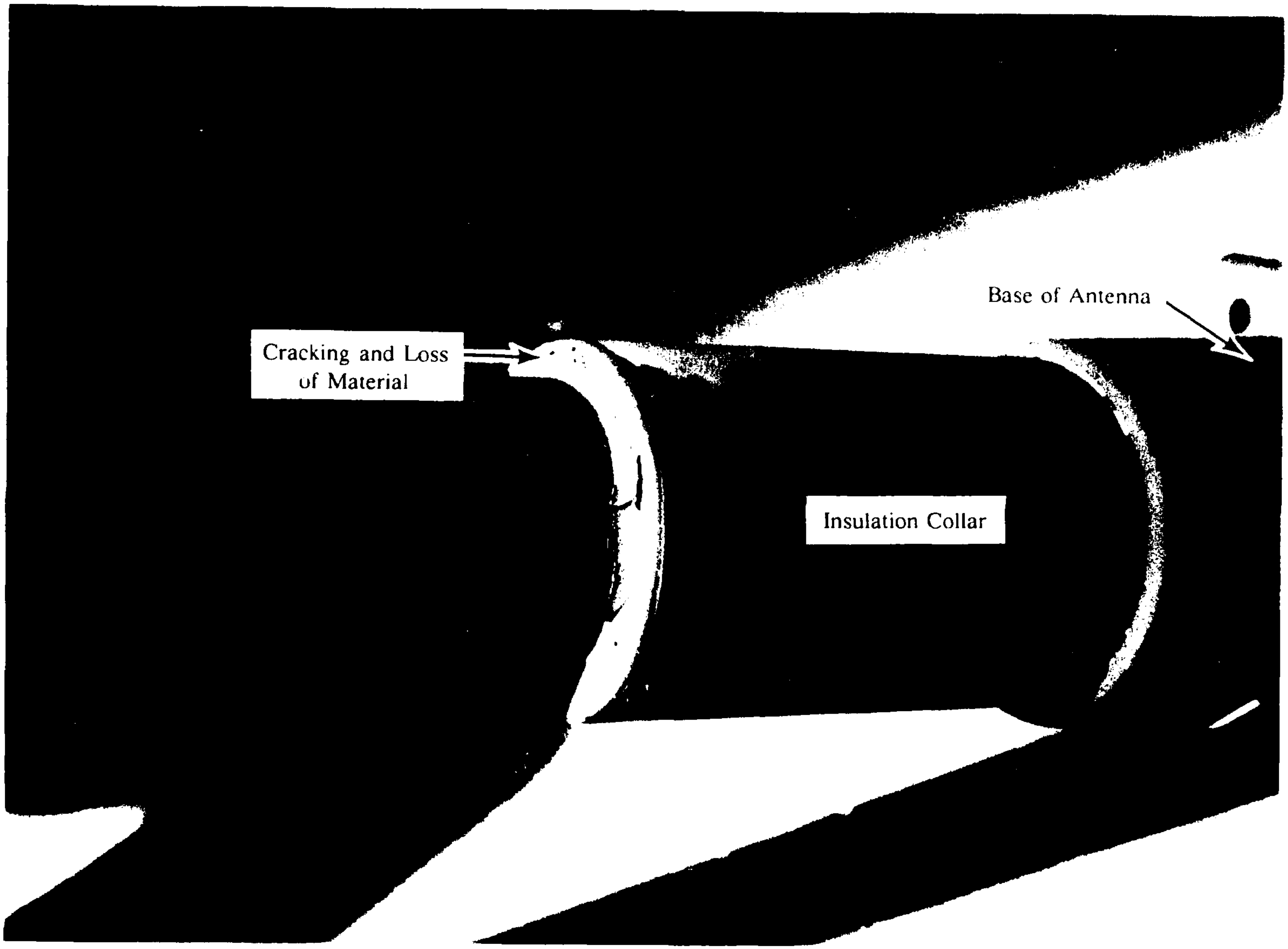


Figure F-7. Damaged ECM Antenna Base

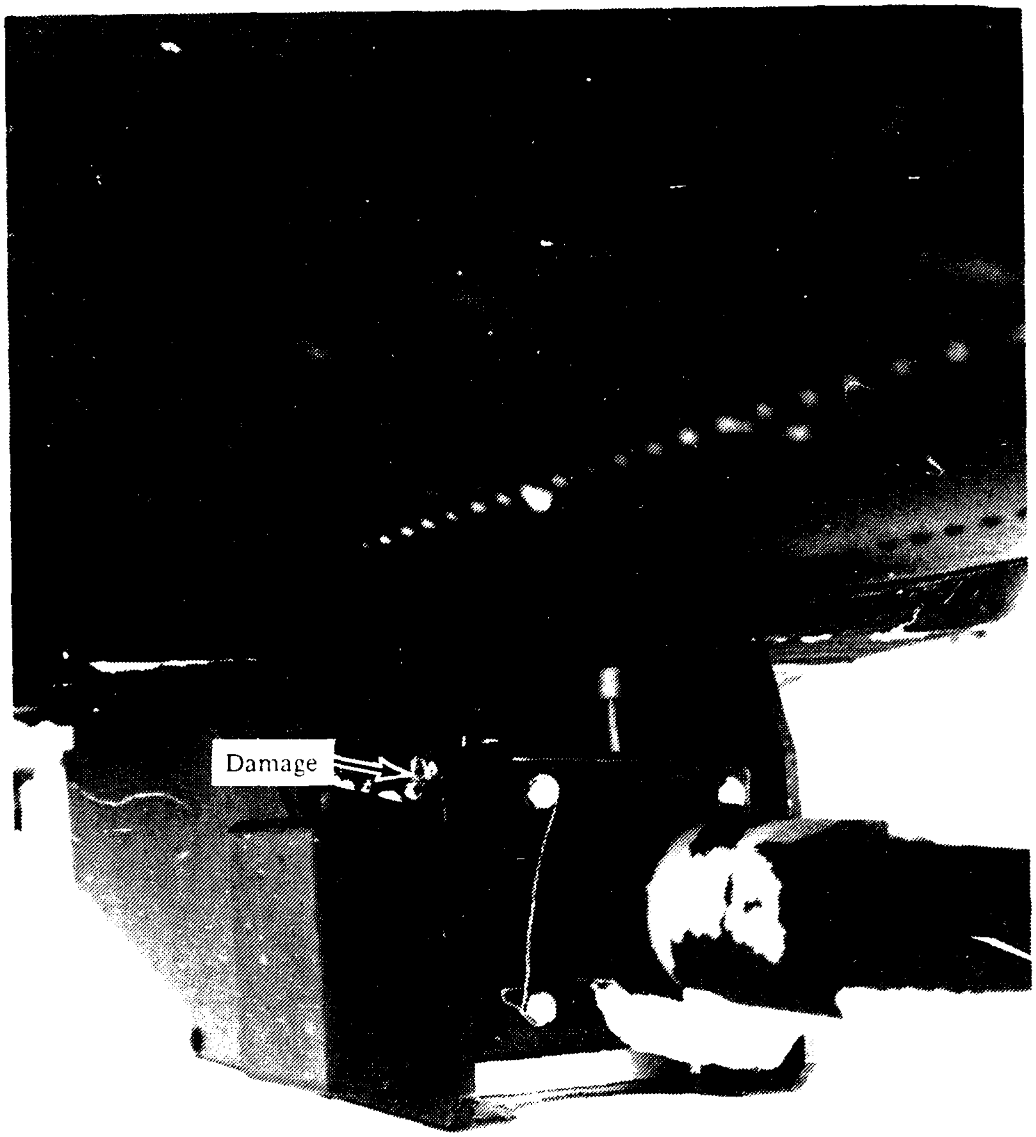


Figure I-8 Damaged ECM Antenna Actuator

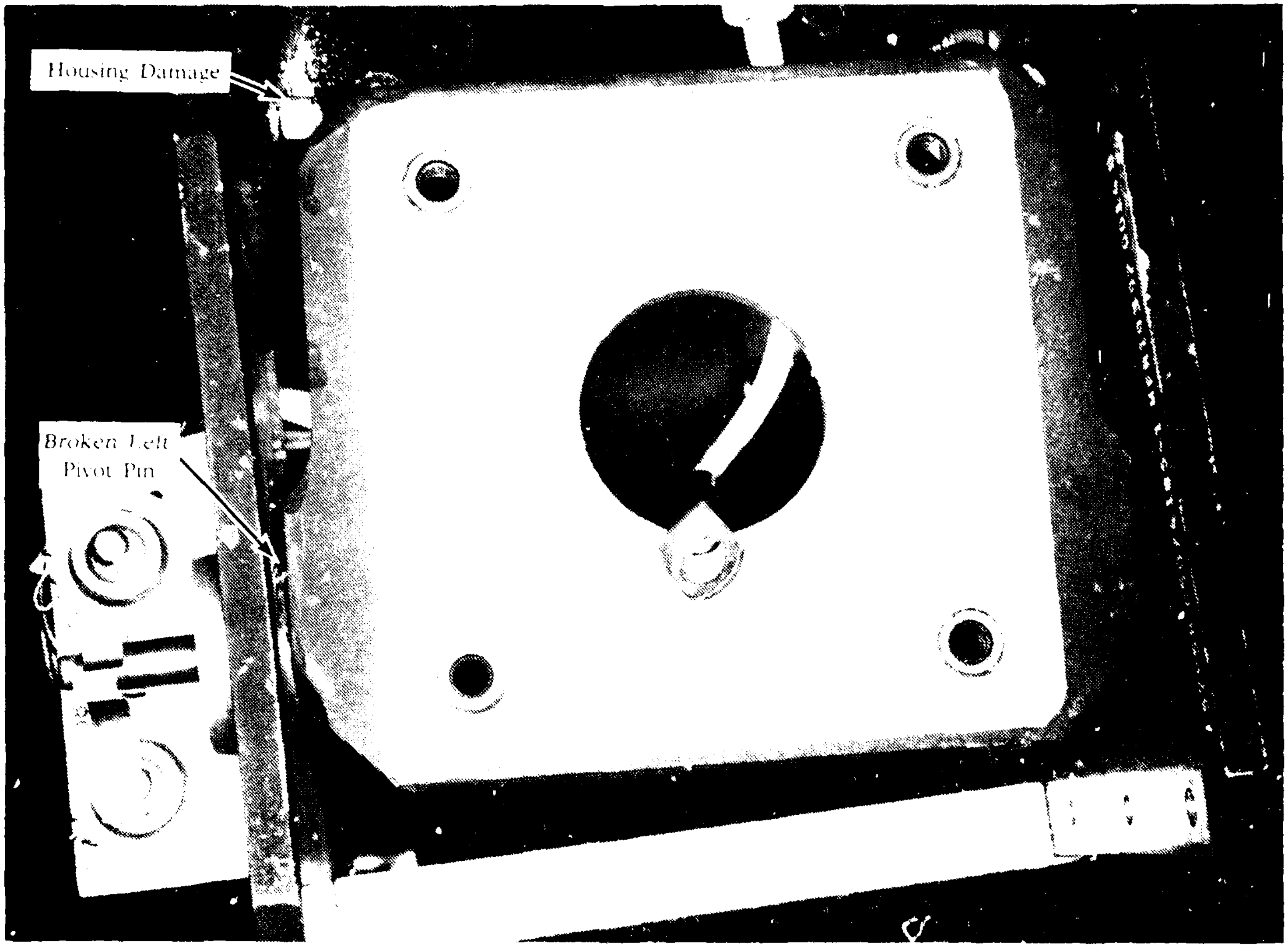


Figure E-9. Damaged ECM Antenna Actuator

Figure F-10. Typical DF Dipole Antenna Ice Accretion (Flight #8)

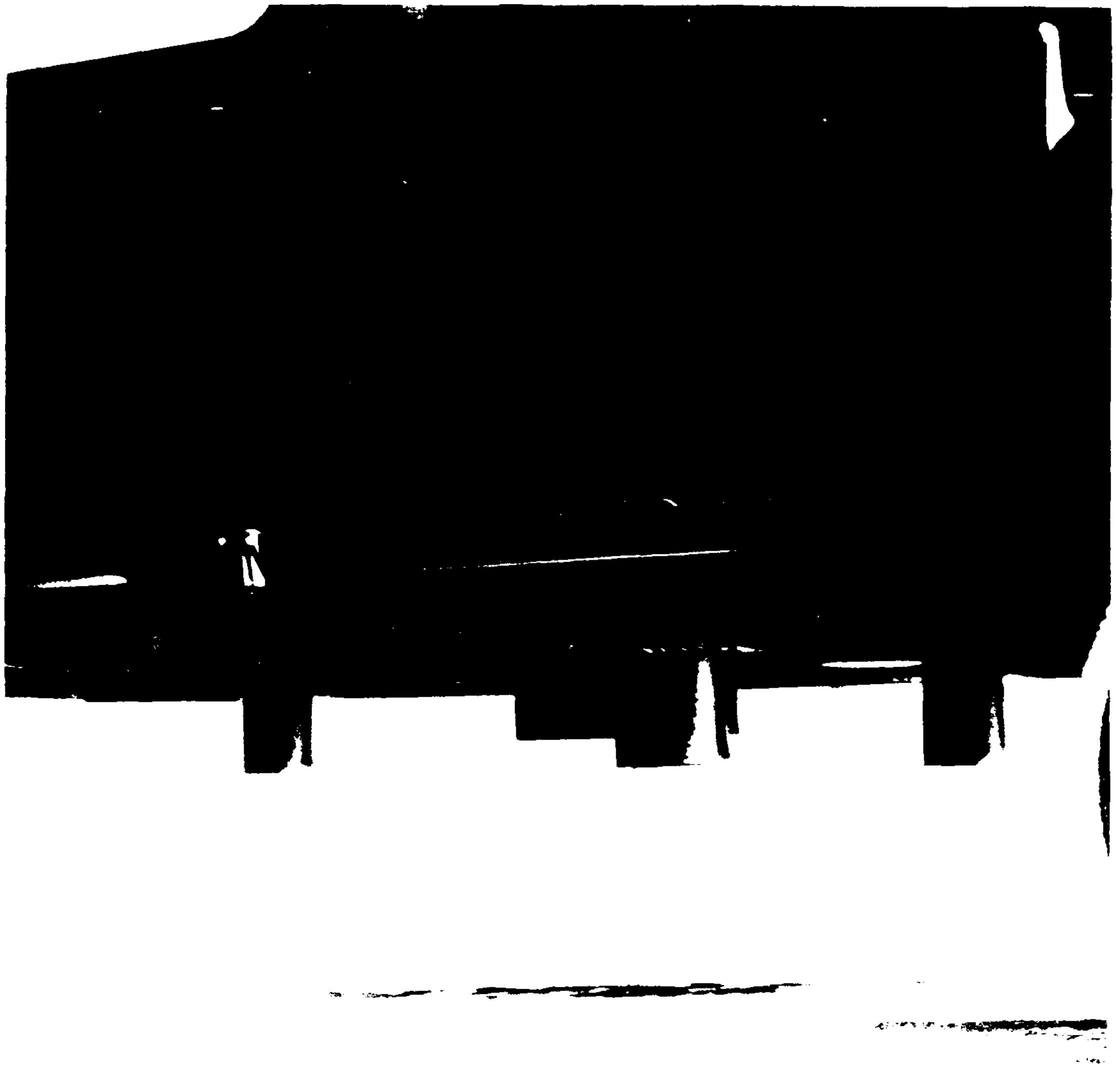


Figure F-11. Typical Dummy Active DF Antenna Ice Accretion

DISTRIBUTION

HQDA (DALO-AV)	1
HQDA (DALO-FDQ)	1
HQDA (DAMO-HRS)	1
HQDA (SARD-PPM-T)	1
HQDA (SARD-RA)	1
HQDA (SARD-WSA)	1
Commander, US Army Material Command (AMCDE-SA, AMCDE-P, AMCQA-SA, AMCQA-ST)	4
Commander, US Training and Doctrine Command (ATCD-T, ATCD-B)	2
Commander, US Army Aviation Systems Command (AMSAV-8, AMSAV-Q, AMSAV-MC, AMSAV-ME, AMSAV-L, AMSAV-N, AMSAV-GTD)	8
Commander, US Army Test and Evaluation Command (AMSTE-TE-V, AMSTE-TE-O)	2
Commander, US Army Logistics Evaluation Agency (DALO-LEI)	1
Commander, US Army Materiel Systems Analysis Agency (AMXSY-RV, AMXSY-MP)	8
Commander, US Army Operational Test and Evaluation Agency (CSTE-AVSD-E)	2
Commander, US Army Armor School (ATSB-CD-TE)	1
Commander, US Army Aviation Center (ATZQ-D-T, ATZQ-CDC-C, ATZQ-TSM-A, ATZQ-TSM-S, ATZQ-TSM-LH)	5
Commander, US Army Combined Arms Center (ATZL-TIE)	1

Commander, US Army Safety Center (PESC-SPA, PESC-SE)	2
Commander, US Army Cost and Economic Analysis Center (CACC-AM)	1
US Army Aviation Research and Technology Activity (AVSCOM) NASA/Ames Research Center (SAVRT-R, SAVRT-M (Library)	3
US Army Aviation Research and Technology Activity (AVSCOM) Aviation Applied Technology Directorate (SAVRT-TY-DRD, SAVRT-TY-TSC (Tech Library)	2
US Army Aviation Research and Technology Activity (AVSCOM) Aeroflightdynamics Directorate (SAVRT-AF-D)	1
US Army Aviation Research and Technology Activity (AVSCOM Propulsion Directorate (SAVRT-PN-D)	1
Defense Technical Information Center (FDAC)	2
US Military Academy, Department of Mechanics (Aero Group Director)	1
ASD/AFXT, ASD/ENF	2
US Army Aviation Development Test Activity (STEBG-CT)	2
Assistant Technical Director for Projects, Code: CT-24 (Mr. Joseph Dunn)	2
6520 Test Group (ENML)	1
Commander, Naval Air Systems Command (AIR 5115B, AIR 5301)	3
Defense Intelligence Agency (DIA-DT-2D)	1
School of Aerospace Engineering (Dr. Daniel P. Schrage)	1
Headquarters United States Army Aviation Center and Fort Rucker (ATZQ-ESO-L)	1

Commander, US Army Aviation Systems Command (AMSAV-ED)	1
Commander, US Army Aviation Systems Command (AMCPM-AE)	2